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"We are going to try a Yankee dodge today, gentlemen, for making men insensible". With these words Robert Liston, the celebrated surgeon, embarked on the first anaesthetic.

The history of medicine is a vast and fascinating subject. With great selective skill the author of this book has "highlighted" the famous moments and famous figures in what we are never allowed to forget has been a long struggle on the part of countless anonymous workers. But even for the fortunate and famous, the announcement of their discoveries, which often followed years of disappointment, was to be followed in its turn by more years of abuse and misunderstanding. And here Dorothy Fisk has seen to it that the technical aspect goes hand in hand with the human story. We learn about the charming personality of Jenner, the tragic madness of Semmelweiss whom no one would believe . . . Nor is the lighter side lacking. A single glance at an early Egyptian prescription should help us to swallow our castor oil with comparative gratitude.

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Sir Alexander Fleming himself, the discoverer of penicillin, has specially written an Introduction to this admirable book, which, as the title shows, is not only a history but a tribute.

BOUQUET FOR THE DOCTOR

BOUQUET FOR THE DOCTOR

by

DOROTHY FISK

with a preface by
Sir Alexander Fleming, F.R.S.

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To

SIR ALEXANDER FLEMING, F.R.S.

and

all those who have gone before and will follow after him in the task of the relief of pain and the saving of life,

ACKNOWLEDGMENTS

I WISH to thank Sir Alexander Fleming for his ready kindness in writing the preface.

I am also deeply indebted to the Director and Staff of the Wellcome Historical Medical Museum for their help in putting at my disposal sources of medical history, both old and new. Their willing co-operation and the pleasure of handling some of the beautiful texts have made the writing of this book a pleasure and a delight.

My debt to previous writers on medicine, surgery and social history is obvious and not to be forgotten, and I wish to include in my thanks several young medical friends who have always been ready with advice and encouragement.

CONTENTS

INTRODUCTION BY PROFESSOR SIR ALEXANDER FLEMING ix

Chapter Page

1. WITCH DOCTOR AND MEDICINE MAN 1
2. THE EARLIEST MEDICAL WRITINGS 14
3. THE DIVINE OLD MAN 33
4. PUBLIC HEALTH AND HOSPITALS 49
5. DOCTOUR OF PHISYK 64
6. ANATOMY AND PHYSIOLOGY 80
7. THE ENGLISH HIPPOCRATES 102
8. A GLOUCESTERSHIRE SURGEON 120
9. SURGICAL INTERLUDE
    1. *Barbers and Surgeons* 147
    2. *The Discovery of Anæsthetics* 154
    3. *The Revolution in Surgery* 164
10. 'MOST WONDERFUL LIVING CREATURES' 181
11. DISEASE AND THE MICROBE 190
12. THE BODY'S DEFENCES 206
13. THE MODERN MEDICINE CHEST 221

INDEX 237

Introduction

by

PROFESSOR SIR ALEXANDER FLEMING

THE author of this book has undertaken a difficult task. To describe all the advances which have been made in medical practice since history began would make a ponderous tome, so the author has had to pick and choose. She has had to confine herself to a series of chapters on some of the more important developments, but it makes an interesting and instructive story.

Nowadays the physician has behind him the physiologist, the pharmacologist, the pathologist, the bacteriologist, the chemist, the physicist and others whose work in the laboratory has elucidated many facts concerning the structure and functions of the organs and cells of the body. He can now give treatment knowing a good deal about how such treatment will affect the organism.

This knowledge was denied the early medicine man, but there can be little doubt that at all times there were honest practitioners who used all their skill and knowledge for the benefit of their patients just as practitioners do today.

The principles which govern medical practice go back a long way, for it was over 2,000 years ago that they were promulgated in the famous Hippocratic Oath which is still subscribed to by our young doctors on qualification.

The advances in scientific medicine have been phenomenal in the last 100 years and perhaps even more rapid during the present century, when we have had two world wars to stimulate and subsidise research in many directions. Surgical operations are relatively safe, anæsthetics are safe and comfortable, sepsis is almost conquered, typhoid and typhus fever have lost many of their terrors, as have the common venereal diseases, and by the use of D.D.T. insect-borne diseases like malaria can be prevented. These are just a few of the changes the present generation have seen, but these advances, combined with improved hygiene, have greatly extended the expectation of life, and this in its turn has revealed new medical and social problems which have still to be solved.

CHAPTER ONE

Witch Doctor and Medicine Man

> *"As there is no man can tell who first contrived the use of Houses and Cloathes to defend us from the injuries of the Weather, so the beginning of the Art of Physick can be no more discovered than the Fountain of the River Nile."*
>
> (THOMAS SYDENHAM, translated by
> JOHN PECHY, M.D.)

IN the earliest times of which we have knowledge medicine, magic, and religion were associated and confused. Medicine could not be called the healing art, for the idea of healing was not yet conceived. Man knew himself in a world of alien and frequently malicious forces: water that hated and therefore engulfed him; cold that did him wilful harm; rain that made his life a misery; and invisible gods, ghosts, and devils that plagued him with famine and with pestilence.

Between himself and these incalculable forces he needed a mediator. The medicine man might, with his magic, exert a favourable influence over ghosts and devils; with the correct ritual he might placate the gods. So persuaded, they might turn aside their wrath in the shape of flood or frost or drought, they might even delay or arrest the short journey between sickness and death.

When called upon to treat sickness—this was not his only function, but it is the only one with which we are here concerned—his first task was that of diagnosis. He had to discover, either for himself or assisted by one whose special gift was divining, the cause of the disorder. It might be traced to the transgression of a taboo, to the Evil Eye, to an offended ghost, to a devil, or to malicious magic; the soul might have been stolen, or it might simply have strayed; an evil spirit might have taken possession. There was a logical connection, apparent to the medicine man if not to us, between cause and treatment, and if the treatment was unsuccessful the reason was not far to seek—gods and spirits are capricious beings and cannot always be coerced.

We are familiar with the doctrine of taboo both in ancient tradition and in the practice of primitive tribes. The apple was taboo to Adam and Eve, and the transgression of the taboo was followed by all the ills that flesh is heir to. Pork was taboo to the Israelites, and if they ignored the taboo they were likely to be afflicted with intestinal worms, of which, pork, in warm climates, is a pregnant source. The doctrine is so old that it seems to be part of man's natural response to the unknown and the incalculable, and he has hardly yet outgrown it. Some scholars think that it originated in a system of preserving property in a simple communal society, or of making obedience sure in minds undisciplined. It was probably imposed in the first case by the medicine man himself and he also had the monopoly of the propitiatory rites. Only Moses could intervene between the Egyptians and Jehovah, as Pharoah well knew. We read in the book of Exodus how the water of the Nile ran red as blood, the fish died in ponds and streams, frogs left the water and took refuge in the houses. A day of summer sunshine and they were dead and putrefying, flies and lice spread infections amongst men and beasts, cattle died, and finally an epidemic killed the firstborn and probably many more than the firstborn. The Egyptians laid each separate affliction at the door of an angry god; modern medical teaching connects one plague with another, beginning with floods in the hills and a polluted water supply, and ending with an acute epidemic. But if the Egyptians were right, and no one, least of all Moses, doubted it, the obvious remedy was to propitiate the deity. Accordingly Moses went off into the wilderness—incidentally, away from infection—to perform the appropriate sacrifices. He was the intermediary between the Egyptians and Jehovah, and to that extent he resembled the primitive medicine man, whose figure can be dimly deciphered in legend and tradition. It was not long before some of his functions were taken over by the newly-created priesthood, and it was not Moses but Aaron and his family who laid down the rules for disinfection, quarantine and hygiene. Medicine and priestcraft were not separate arts for long ages to come, and so deep-rooted is the connection between them that even today there is a strong movement to revive it.

The medicine man, however, had to deal not only with god or gods but also with powers less august—spirits, ancestral ghosts, devils, sorcerers. What was he like, then, this man or superman, whose function was to control the dark powers that dealt disease and death?

All that we know of him is by analogy with the medicine men still practising their art in primitive tribes, or with those who have survived into historical record. From them we learn that the office was generally hereditary, as the priesthood was in the family of Aaron, and the profession of physician in the family of Hippocrates. But the system of keeping the secrets of the art in one family was not always practicable, and then some method of selection had to be devised. A child might be chosen by the medicine man himself, or by the tribe, or he might be dedicated by his parents. In most cases some physical peculiarity marked him out for the profession: twins, albinos, those born blind, or those born feet first were often selected, or the seventh son of a seventh son, no daughters intervening—this is the magic of numbers, for the number seven has been credited with mysterious powers since arithmetic began. A fit of any kind was looked upon as possession by spirits, and such intimacy was held to imply influence; for this reason epileptics often became medicine men. Those who survived great danger were thought to have done so by means of magic, which they were thenceforward expected to exercise for the benefit of the tribe. Amongst the aborigines of Victoria there is a story of a man who was sawing a lofty branch from a tree, sitting, whilst he did so, on the outer side of the incision. When the branch fell he fell with it, but was fortunate enough to come to no harm. The tribe, far from thinking him stupid, credited him with being a powerful magician, and made him their medicine man.

The initiation ceremony was probably a compound of drama and endurance tests. The death and resurrection of the initiate were often enacted. This may have been the age-old drama of the seed that is buried in the earth to rise again into new life, or it may have borne the narrower significance of the medicine man's power over life and death. Ideas may intermingle and colour each other, and seed-time and harvest, the cold earth's turning to the warmth of spring, birth and death and resurrection may all be expressed by similar symbols variously interpreted. In some communities the initiate was segregated and starved, in some he was beaten, in some he was mutilated, for blood played an important part in healing as in sacrifice. That the ordeal was severe we may take for granted, and the medical student of today may comfort himself that, however hard on him the examiners may seem to be, they will never go to the unfeeling lengths practised on primitive initiates.

Initiation might precede, or more often succeed, a prolonged course of instruction. The secrets of the art were closely guarded and all that we know of them is what survives in folk medicine the world over. There were charms to be learnt, rituals to be observed, herbs and magic substances to be recognised and put to their prescribed uses. And in addition the magnificent art of make-up had to be learnt, for the medicine man was a gorgeous and a formidable figure. The book of Exodus describes minutely the jewelled vestments devised for the sons of Aaron, and it is unlikely that the medicine man was less impressively attired. He was painted and sometimes masked; rattles and gongs were part of his equipment—precursors of the handbell carried, with book and candle, by the mediæval priest when exorcism was required. Dimly though we see him, the medicine man must have been a person calculated to awe, and even to terrify, not only gods and devils, but also the simple folk in days when thought had barely words in which to clothe itself.

The most powerful medicine at his command, whether he realised it or not, was suggestion. Primitive man was an extremely suggestible subject. If he believed that he had broken a taboo and would therefore die, he was liable to die. Similarly if the medicine man performed propitiatory rites and told him that he would recover, he was liable to recover. In this instance suggestion was both cause and cure. The case was more difficult if he were suffering from injury or disease. The appropriate rites might be performed thrice over, but without the help of mother nature he would be little the better. But even the National Health Service would be reluctant to embark on its curative career without the help of mother nature.

Suggestion probably began with auto-suggestion. The medicine man would work himself up into a frenzy by means of dance and clamour; fasting, continence, and flagellations would raise his emotional temperature, and such intoxicants as he knew of would increase his confidence in the potency of his remedies.

In this state of enthusiasm he would recite or intone charms learnt from his predecessors, or, if he had the gift, he might even invent a new one of his own. It has been suggested, though the theory has not much support, that the word charm survives in the word carminative, a soothing medicine, and in this sense might still be applied to the recital of some ancient gibberish. Originally the charms no doubt had a glimmering of sense in them, but they have been passed on orally from one generation to another until even the language in which they were couched has sometimes been forgotten.

Many of these old charms survive in country districts, not old enough, perhaps, to belong to primitive medicine, but conforming to similar patterns, a Christian descant added in later days to the pagan theme, to make them more tunable to the converted ear.

A 'withering away' charm from Cornwall may be quoted as an example. It is a cure for the bite of an adder, and whilst it is recited a cross of hazel-wood must be placed over the wound. As the numbers in the charms decrease the pain decreases, until with 'no double' it vanishes altogether—unless perchance an encore is required.

"Underneath this hazelin mote
There's a *braggoty worm with a speckled throat
Nine double is he;
And now from nine double to eight double
And from eight double to seven double
And from seven double to six double
And from six double to five double
And from five double to four double
And from four double to three double
And from three double to two double
And from two double to one double
And from one double to no double
No double hath he."

Another example is given for the convenience of those who fear that a solitary magpie (a rare sight except to the impatient) threatens ill-luck. A letter in *The Times* once gave the assurance that the recital of this verse, its original paganism glossed over with Biblical authority, will neutralise the threat.

"Clean birds by sevens
Unclean by twos
The Dove in the heavens
Is the bird I choose."

The recital of the charm was accompanied by appropriate action, which could take the form of dance or mime or of a combination of the two. Mimetic magic, according to Sir

---

* Spotted.

James Frazer, is a form of sympathetic magic, and ranges from dramatic representation of a cure to the application of the remedy (for example the 'sympathetic powder') not to the wound but to the object that inflicted it. The cure, and equally well a curse, might be mimed with an effigy, a practice as old as Babylon, and probably much older. The Babylonians used clay, honey, or fat for making their manikins, and whatever treatment the effigy received was duplicated on the subject represented.

A Babylonian hymn to the fire god Nusku illustrates the sinister aspect of mimetic magic and the means taken to counteract it.

"Those who have made images of me, reproducing my
  features,
Who have taken away my breath, torn my hairs,
Who have rent my clothes, have hindered my feet from
  treading the dust,
May the fire-god, the strong one, break their charm."

There may be a connection between mimetic magic and the Jewish commandment against making a graven image, and also the Arabian veto on portraying the human form. It survives, too, in the votive offerings of wax still seen in some of our churches, placed before the Virgin in the hope of attracting divine healing.

Contagious magic, also a form of sympathetic magic, required no effigy. It worked on the assumption that things that had been in close contact with man—hair, or pared nails, food left uneaten, or some object frequently handled—maintained that relationship even to the point of identification. Hence the remedy applied to the battle-axe that had inflicted a wound, or to the bloody cloth that had bound it. Hence, too, the superstition that a baby's nails should never be cut, lest some ill-wisher obtain possession of them, with who knows what dreadful consequences to the baby. Like the totem, they should be bitten off and swallowed.

Belief in possession by evil spirits dictated the form of many remedies. We ourselves sometimes remark, "He is not himself today," though we do not explain who else he is likely to be. The medicine man had the answer. The patient was not himself, because his self or soul had been supplanted by an evil spirit. The soul, so he believed, was but casually attached to the body, and left it in dreams or in moments of preoccupation, when it might be caught unawares and carried off by some devil or spirit anxious to take possession of the untenanted body. Many spiritualists hold the same belief. They can quote scripture to support it, and members of the early Christian Church went about casting out devils as a recognised part of their ministry. Transference cures, such as that of the Gadarene swine, were among the accepted methods of casting them out. In *Aylwin* Winifred's madness is transferred to the gypsy Sinfi Lovell.

The medicine man probably made use of the transference cure, but it was not his only means of dealing with possessing devils. They might be shot with a magic bullet, or with an arrow that had already killed a man; or their habitation, the body of the unfortunate patient, might be made so uncomfortable that they would abandon it. He might be fumigated, beaten, rubbed or dosed with excreta, immersed in cold water. Some remedies were so revolting that the patient might well have preferred his devil after all. Unfortunately we cannot regard them as exclusively primitive. Some of them were still in use for the cure of lunacy until the nineteenth century.

The soul might be stolen without being replaced, or it might get lost in a too adventurous dream, forgetting the way by which it should have returned. In that case transference or an attack on the possessing spirit were inappropriate. The soul must be found and induced to return by charm and incantation. We might still be the happier for some such charm that would recall to us our better selves.

Rite, mime, and ceremony were the spectacular side of the medicine man's procedure. But he also administered medicine in the modern meaning of the word. Many of his remedies were, like his mimes, homeopathic. *Similia similibus curantur*—like cures like—is a belief to which man clings obstinately. In the eighteenth century Hahnemann of Leipzig systematised the teaching in a form in which it is still current, that is to say that small doses of those drugs that would produce symptoms of disease in a healthy person will cure the disease in a sick one, or, to quote a familiar instance, the hair of the dog that bit you is a sure remedy for the 'bite'. The medicine man's practice was still more closely akin to that devoutly summed up in the Doctrine of Signatures: "When God created man and made him subject to ills and misfortunes he also created stones, plants, animals and other human beings and marked them with characteristic marks to be used as remedies." It was in the catholic spirit of this seventeenth-century doctrine that the medicine man chose his treatment. For jaundice he might prescribe a yellow flower, a yellow stone, exposure to the yellow sun or even looking steadily in the yellow eye of a stone curlew. The use of red flannel for the cure of small-pox, scarlet fever, and other inflammatory conditions is founded on the same principle, for whoever heard of white flannel having any efficacy?

It is possible that totemism had some part in the origin of a number of primitive medicines. If it is kept in mind that over-simplification does less than justice to truth, totemism may be defined as the derivation of a tribe or family from some animal, or, less frequently, plant or a close association with it. The totem is sacred to the tribe; if it is injured the tribe suffers; if it dies the tribe dies too. But there is one significant exception to the rule. The totem on certain ceremonious occasions is killed and eaten by the assembled tribe, who renew in this way their life and vigour. It must not be eaten by a member of any other tribe, and it must be completely consumed, skin, bones, and even teeth, so that in death it is one with the tribe and continues to thrive as they thrive. If any injured relic remains, the tribe will suffer similar injury. Most of what we know of totemism comes to us from the North American Indians; the word itself derives from an Algonkin dialect, but the origin of the cult is prehistoric, and relics of it are evident in the animal gods of Egypt: Ra with the hawk head, Osiris who is identified with the ox, the hyena-like Set; in the animal incarnations of the Indian Vishnu—fish, tortoise, boar, and the like; in the goat-like Pan of the Greeks; and in the association of gods with their peculiar creatures, Athene with her owl, Hera her with peacocks, and, still more appropriately for our purpose, Aesculapius with his snakes.

The totem feast, then, is a possible origin of some of the medicine man's animal remedies, but this does not rule out his belief in the transference of attributes by the process of digestion: the heart of a lion makes man lion-hearted, bear's grease makes his hair grow, tiger's flesh gives him strength, the hare's legs swiftness. There is scarcely any part of an animal that in some part of the world at some period of time has not been valued for its curative qualities, and after many centuries of complete disregard of cause and effect a few of them have survived into the modern pharmacopœia—hartshorn as liquid ammonia, wool grease as lanoline, bee venom as formic aldehyde, ox-gall as *fel bovinum*. The list is not a long one, for most animal extracts in use today were unknown to the ancients.

Blood, urine, and dung are animal remedies with quite different associations. Blood was looked upon as the source of life, or as life itself, for as it ebbed away from some mortal wound the patient died. It was also connected with sacrifice. The custom of piercing the ear may be a symbolic relic of human sacrifice, for which, in the progress of civilisation, an animal, as in the case of Isaac, was substituted, and eventually merely a symbol. Or the custom may have arisen simply from the fact that the ear-lobe is a convenient place for obtaining a few drops of blood, which can be administered as a remedy.

Urine was a very important item in the medicine man's list of remedies, and was used both for treatment and for diagnosis. Asu, 'one who knows water', was the Sumerian word for physician, and 'Carry his water to the wise woman' was Fabian's plea for the diagnosis of Malvolio's madness, a mediæval relic of primitive medicine. One of the uses of dung has already been mentioned. It crops up again and again through the centuries. Could it possibly be the origin of the belief that the nastier the physic the more likely it is to do the patient good?

Religion, totemism, and homeopathy may all have had something to do with the origin of herbal remedies; there can scarcely have been a plant or tree of any note that has not at some time been used by medicine man or physician. Mistletoe, the golden bough that protected Aeneas in the underworld, has been held for countless ages to have magic properties, and has been used both internally and externally against epilepsy, palsies, poisons, and—its active principle isolated as guipsine—for the relief of arterial hypertension. It is a plant that arrests the attention, especially in autumn when its leaves turn yellow, and its strangeness may have been sufficient to account for the veneration in which it was held. The elder, *sambucus nigra*, with its green and crimson leaves that turn to palest gold, was also sacred, and at various times has been held to cure—used externally as a charm or internally as a medicine—erysipelas, jaundice, burns, colic, and sore eyes.

The use of mandrake may go back as far as cannibalism and ritual murder; in mediæval times it was used as a substitute for mumia, or human remains, a remedy evolved from the same source. According to the Old Testament it was mandragora that Reuben gathered for his mother Leah when she had passed the age of child-bearing, and it was mandragora that the barren Rachel begged from her more fortunate sister. Its use to induce fertility was homeopathic, for the root, not unlike the forked radish to which he has also been compared, bears an uncanny resemblance to a little man. According to the story, Leah subsequently gave birth to two male children, but as Rachel bore both Joseph and Benjamin without the aid of the mandrake root the evidence must have seemed inconclusive. Whatever its efficacy, it remained a highly valued remedy, and in mediæval times was believed to act not only as an opiate, but also as a love philtre, a means of discovering hidden treasure, and as a protection from evil spirits.

But it had its drawbacks. Juliet speaks of

> "Shrieks, like mandrakes torn out of the earth
> That living mortals hearing them run mad."

The baleful noises that it made as it was gathered might even prove fatal. But there were ways of avoiding such dreadful consequences. The Roman herbalist stood with his back to the wind, drew three circles round the plant with the point of a sword, then, turning to the west, was able to pull it up with impunity. The mediæval herbalist was even more cautious. Ulysses-like he filled his ears with wax, loosened the earth about the plant, and fastened it firmly to the tail of a dog. He then retired to a distance and persuaded the dog to jump. The mandrake shrieked, the dog fell dead, and the herbalist obtained his prize.

The story of herbal remedies might be prolonged indefinitely. No doubt each medicine man made concoctions of such herbs and roots as were to be found in his own neighbourhood, and knowing little of their efficacy preferred those that were brightly coloured or in some way unusual. Knowledge of these herbs was passed on from one generation to another, and from one district to another, so that the number of medicinal herbs in use multiplied as time passed and as communications improved. By the beginning of the ninth century A.D. there were in use in China alone no less than 11,886 prescriptions, and there was nothing to prevent any tribal medicine man or village wise woman from adding to the number.

When disease and death are directly due to gods, ghosts, and devils the effect of any particular concoction on the human organism is of little importance. It is faith that kills or cures—faith and the natural capacity of the body to heal itself. The figure of the medicine man of primitive times is tragic rather than comic. Knowledge had no highways, and only tentative and uncertain tracks led beyond the immediate limits of sensation. He must blaze his own trail or wander as best he might in the darkness of the unknown. But in such tragic beginnings the profession of medicine has its roots. The humbleness of its origins is less to wonder at than the greatness of its achievements.

CHAPTER TWO

The Earliest Medical Writings

"*The charms have great power over the remedy.*"
(the EBERS PAPYRUS)

FROM the mists of folk-lore and legend medicine emerges slowly into history. The earliest written records in existence are Egyptian, and date from the second millennium B.C., but it is probable that prescriptions—if charms and incantations may be dignified by the word—were written down at a still earlier date.

The Sumerians, after wandering for uncounted years in unknown regions, where they developed some degree of civilisation, settled in the fertile land between the Tigris and the Euphrates about the fourth millennium B.C. It is to them we owe the invention of the art of writing. They wrote their prescriptions with styles, similar to the modern stylo pen, on moist clay tablets, which were afterwards baked, or dried in the sun. Unfortunately they were very fragile and none of the earlier specimens have survived. The earliest examples are the fragments unearthed in the ruins of Nineveh, which was destroyed in the seventh century B.C. They are supposed to have formed part of the library of King Ashurbanipal, and are not as old as many of the Egyptian papyri. The medical practice they depict, however, is more primitive, and had probably changed little for many thousands of years. The only important respect in which it differs from that of the primitive medicine man is in the recognition of medicine and surgery as professions to some extent separate from priestcraft, though still closely associated, for gods and devils were the concern of all three.

It is plain that the Sumerians believed, as did their conquerors the Babylonians, that diseases were due to the malevolence of supernatural beings. There were gods and goddesses of pestilence and of healing, and there were spirits of the dead who returned vindictively to earth. Namtar, the plague god, could strike man with sixty different diseases, and he and his wife Khushbisag begot a family of devils who increased the number still further. Such a variety seems too large to allow of classification based on the locality of the affliction, and might almost be taken to suggest that observation was becoming more particular.

Since diseases were the work of occult powers, treatment must take the form of spell and incantation directed to the undoing of the work of malevolent spirits and invoking the aid of the benevolent. Many fragments of these spells survive. They show that dramatic dialogue was already well developed and played a large part in the healing art. One incantation that has been recovered and translated is in the form of a dialogue between Mirri-Dugga, the son and mediator, and his father Ea, the spirit of earth and god of all knowledge and wisdom. The pouring out of the water on the highway, and with the water no doubt the disease, suggests a form of sympathetic magic, whilst the invocation to Damkina, the earth mother of Mirri-Dugga, suggests a very ancient origin of the idea of the divine mother as advocate and mediator.

The invocation is quoted from *Medicine Among the Assyrians and Egyptians in* 1500 B.C. (Comrie) and runs:

> "The disease of the head has issued from the Abyss, from the dwelling of the Lord of the Abyss.
> 'My father, the disease of the Head has issued from the Abyss.'
> A second time he has spoken unto him:
> 'What he must do against it the man knows not. How shall he find healing?'
> Ea has replied to his son Mirri-Dugga:

> 'My son, how dost thou not know? Why should I teach thee? What I know thou also knowest. But come hither, my son, Mirri-Dugga. Take a bucket, fill it with water from the mouth of the rivers; impart to this water thy exalted magic powers; sprinkle with it the man, son of his god, . . . wrap up his head . . . and on the highway pour it out. May insanity be dispelled! that the disease of his head vanish like a phantom of the night. May Ea's word drive it out! May Damkina heal him!' "

Another incantation is intended for recitation whilst an onion is peeled, skin after skin, and thrown into the fire, a form of mimetic magic which is in this case an omnibus kill-and-cure. It is interesting to note that the onion is considered fit for a feast of god or king, a taste which many will still approve. The spell is quoted from the same source as the previous one.

> "As this onion is being peeled of its skins, thus shall it be of the spell. The burning fire shall consume it; it shall no more be planted in a row . . . the ground shall not receive its root, its head shall contain no seed, and the sun shall not take care of it; it shall not be offered at the feast of a god or a king. The man who has cast the evil spell, his eldest son, his wife, the spell, the lamentations, the transgressions, the written spells, the blasphemies, the sins, the evil which is in my body, in my flesh, in my sores, may they all be destroyed as this onion, and may the burning fire consume them this day! May the evil spell go far away, and may I see the light again."

These spells and others like them depict a medical practice essentially primitive. Education in the three Rs had gone on for many hundreds of years, but medicine had made no progress at all. The practice of surgery, however, does seem to have advanced a little. The Sumerians had learnt something of the craft of working in metals, and simple surgical instruments were in use for the treatment of wounds and injuries. The Code of Hammurabi, King of Babylon, which is the earliest known code of laws, shows that the services of the surgeon, however ineffectual, had a definite cash value as early as 1920 B.C., and his fees were laid down with a precision worthy of a national health scheme. It is interesting to note that the principle of grading fees according to the means of the patient was in force some four thousand years ago. The following clauses illustrate the practice of the period:

> "206 If a man wounds a man in a quarrel accidentally, he shall pay the doctor.
> 215 The doctor who treats and cures a gentleman's wound or has operated on the eye with a copper lancet shall charge ten shekels of silver.
> 216 If the patient be the son of a poor man he shall take five shekels of silver.
> 217 If the patient be a gentleman's servant, the master of the servant shall give two shekels of silver to the doctor.
> 218 If the doctor operates on a wound with a copper lancet and the patient dies, or on the eye of a gentleman, who loses his eye in consequence, his hands shall be cut off."

A shekel of silver, in so far as equivalents have any meaning in a time of rapidly-changing monetary values, can be assessed at approximately half-a-crown, so the poor man must pay about twelve-and-sixpence, whilst the master paid for services rendered to his seemingly not very valuable servant only five shillings. A fee of twenty-five shillings for a gentleman can be called adequate but not excessive, but the same cannot be said of the penalties. A single failure might well cut off the young surgeon in his apprentice days, and he is a fortunate practitioner who avoids a mistake all his life. In Babylon he could never make two.

When we come to the records of Egyptian medicine we find that, although it is involved as deeply as ever with magic, some improvement is evident in diagnosis and treatment. Disease is still the work of occult powers, and magic must be countered by magic, but the physical ravages caused are susceptible to treatment by practical means; symptoms as well as cause therefore receive attention. No better picture of Egyptian medicine can be given than that recorded in the ancient papyri, of which the two most important are the Edwin Smith Papyrus, and the Ebers Papyrus, which were both discovered in the year 1862, the one by an American, the other by a German scholar.

The Edwin Smith Papyrus is, unfortunately, not complete. It is a manual of surgery, containing 577 lines of writing, in which are described forty-eight cases of injury to the bony framework of the body, beginning at the head, and ending abruptly in the middle of a sentence concerned with an injury to one of the vertebræ: "He should place him prostrate and make for him——" but what he should make for him we can only guess.

Professor Breasted explains that the papyrus is a copy made by a scribe about 1600 B.C. of a much more ancient text, which probably dealt with the whole body, and was complete at the time the copy was made. Already, in the year 1600 B.C. this work was old enough for some of the expressions used in it to have become obsolete and to require explanation, which is supplied, in no less than seventy instances, by the scribe.

"Concerning 'Moor him with his fingers'," he writes, "it means to put him on his accustomed food without giving him medical treatment," and Dr. Breasted further elucidates the idiom by reminding us that the Egyptian eats with his fingers.

The cases are dealt with systematically. First the name of the injury is given, then a short description of the examination required, followed by a diagnosis. Then there is a choice of three 'verdicts', either 'an ailment I will treat', 'an ailment I will contend with', or 'an ailment I will not treat', a cautious method of procedure for which the Egyptian surgeon may have had as good a reason as the Babylonian. If treatment is to be given, it is described.

Professor Breasted writes of this document: "The class of men thus revealed to us are the earliest natural scientists of whom we know anything, who, confronting a world of objective phenomena, made and organised their observations and based inductive conclusions upon bodies of observed fact."

It is probable that surgery was always less involved with magic than medicine. The cause of wounds and injuries was easier to discover than the cause of an internal pain, and although weapons might be influenced in their course by spirits, the fact might often be overlooked whilst practical treatment was applied. Only one of the cases in the Edwin Smith Papyrus is accompanied by a charm, and this was probably not written by the original author.

The Ebers Papyrus is concerned more with medicine than with surgery, though there are cases where the use of the knife is recommended. The 875 recipes it contains are frequently allied to magic: there are only 47 diagnoses, and the 'words to be said as one drinks the medicines' are of the utmost importance. It is, however, a complete work—the oldest complete medical textbook in existence—and it contains 2289 lines of writing, more than six times the number in the Edwin Smith Papyrus. Before quoting from it some account should be given of its discovery.

One day, in the year 1862, a wealthy and rather shifty Egyptian came to Georg Ebers, the Egyptologist, who was spending the winter at Thebes, and tried to sell him a practically worthless papyrus, and a modern and quite worthless statue of Osiris. Ebers pronounced the goods valueless, but said that if the Egyptian had anything genuine for sale he would be glad to consider it. The next day the Egyptian returned, bringing with him a papyrus that had been found fourteen years previously between the legs of a mummy in some tomb near Thebes. The man who had made the discovery was already dead, and the location of the tomb was not known.

To the practised eye of the Egyptologist the papyrus was obviously genuine and of great worth. Unfortunately the price asked, though not above its evident value, was far above the means at his disposal, and it was not until a fellow countryman, Herr Gunter, had bridged the financial gap that Dr. Ebers was able to gain possession of it and carry it off in triumph to the University of Leipzig. There he and his colleagues spent three years in studying it, and at the end of that time were able to send facsimile copies to the great national museums, together with a German translation and the necessary glossaries. It was a great feat of scholarship, and it is fitting that the name of Georg Ebers should be associated with the treasure that had come his way.

For close on a century the Ebers Papyrus has been examined and discussed by Egyptologists, and the main facts about it are no longer in dispute. A calendar on the back of the manuscript helps to fix its date, and other corroborative evidence shows that it was written—or again, transcribed is perhaps the more illuminating word—about a hundred years later than the Edwin Smith Papyrus, in the reign of King Amen Hotep of the 18th Dynasty, that is to say between the years 1553 and 1550 B.C.

It is not an original work, nor is it, like the Edwin Smith Papyrus, a copy of a single earlier work. It is an anthology of recipes, charms, and descriptions of diseases, gathered from various much earlier sources. It has been suggested by Warren Dawson that some of the originals may have been written as early as 3400 B.C.

The writer claims Hermes as the original author. He may have been the first to set the literary fashion of attributing authorship to some fictitious but authoritative hand. It was a fashion much followed in the Middle Ages, and frequently employed by the early English novelists. We are asked to believe, for instance, that Pamela's engaging letters were written by a servant girl as accomplished as she was virtuous, and that a sailor, more versed in the language of the pulpit than of the fo'c'sle, wrote *Robinson Crusoe.* The fashion is not yet outmoded, and the 'ghost-writer' can claim a highly respectable antiquity.

Hermes, however, was a more substantial figure than Pamela, and may have had more to do with authorship than Alexander Selkirk. The Egyptians knew him as Thoth, god of the healing art, and his prototype was probably Imhotep, and certainly mortal. It must be borne in mind that as, in the Christian era, saints are canonised for their virtues, so, in times more ancient, distinguished men and women were deified—for various reasons. Imhotep lived in the fourth millennium B.C., a learned physician of great merit and reputation. He—or Thoth, or Hermes, for they were all one—was credited with the authorship of forty-two books, six of which were concerned with medical subjects, and one of them, number forty, with remedies. The writer of the Ebers Papyrus may have had this Hermetic book, number forty, in mind as his original. However that may be, it is not unreasonable to accept the fact that many of the prescriptions derive from sources so ancient that they make Stonehenge seem young.

The Ebers Papyrus is divided into 108 sections, each containing an average of twenty-two lines of horizontal writing, and comparable to the pages of a book. This method of division was an important stage in the development of the book as we know it, for the earliest papyri had been written vertically, with no set divisions in the length of the roll. Then, for greater convenience in reading, a horizontal script came into use, divided up as in the Ebers Papyrus. When these manuscripts came to be stored in the Library of Alexandria it was found more convenient to cut them up, and thus, with the addition of book boards and binding, the modern book came into being.

The sections of the Ebers Papyrus are numbered 1 to 110, numbers 28 and 29 being omitted. Why this should be so in a work that shows every evidence of care and deliberation is a problem. Were the numbers 28 and 29 unlucky? or the total of

108? Alternatively was the number 110 a propitious one? And if so, why did not the author add a couple of sections to make up the number?

The text is exquisitely written in black, with headlines and capitals in red, still fresh and glowing after thousands of years of burial. The script is hieratic, a cursive writing evolved from the earlier hieroglyphic, which was a picture-writing formalised in a manner suitable for incising in stone. Hieratic script was used by the priesthood who, for many centuries in Egypt, as later in Europe, constituted the learned class; it was not until the eighth century B.C., when learning had become less exclusive, that Demotic, the popular script, came into being.

The close connection between religion and medicine is evident in the introduction. It is Ra, the most powerful of the Egyptian gods, who takes pity on suffering man; Isis, the mother-goddess, heals him of his afflictions as she healed her son Horus; and the risen Osiris, judge of the dead and ruler of the Underworld, delivers him from evil. There is a tentative feeling after religious themes that were eventually to find fuller expression and richer orchestration—the compassion of Ra, the 'quickening' of the object of his love, the healing power of the mother-goddess, the suffering son. The 'baptism' of fire and water is, no doubt, a relic of a mimetic ritual for bringing rain and sunshine in due season, one of the normal functions of the medicine man.

But these themes must not be over-emphasised at the expense of the 'inflictions of all the gods'. It is against them, the workers of magic, the 'bad typhonic things', the 'demoniacal and deadly diseases', that medicine must be directed. Remedies are useless without charms, and the prescriptions, however complicated, and however drastic in their effects, will be of no avail unless the High Ones who cause the disease can be frustrated.

The quotations that follow are taken from *The Papyrus Ebers*, translated from the German version by C. P. Bryan. The introduction runs:

"THE BEGINNING OF THE BOOK ON THE PREPARATION OF MEDICINES FOR ALL PARTS OF THE BODY OF A PERSON. I came forth from Heliopolis with the priests of Net-Aat, the Lords of Defence, the Kings of Eternity and Protection. I came forth from Sais with the maternal Goddesses who grant me protection. Words were given me by the Lord of the Universe wherewith to drive away the inflictions of all the gods, and deadly diseases of every sort.

SO MANY CHAPTERS ARE on this my head, this my neck, these my arms, this my flesh, and these my limbs to punish the scoffings of the High Ones who cause this disease to enter my flesh by working magic in these my limbs, so that as often as the disease penetrated into this my flesh, this my head, these my arms, into my body, and into these my limbs, Ra has compassion saying: I will protect him from his enemies. His leader, Hermes, it is who has given him the words, who provides the books, and who bestows upon the learned ones and on the physicians who follow him the glory of unravelling that which is obscure. Whom God loves he quickens. I am one whom God loves, therefore he quickens me.

WORDS TO BE SPOKEN IN THE PREPARING OF MEDICINES FOR ALL PARTS OF THE BODY OF A PERSON WHO IS ILL. As it is to be, a thousand times. This is the book for the healing of all diseases. May Isis heal me even as she healed Horus of all the pains which his brother Set has inflicted on him when he killed his brother Osiris! Oh Isis, thou great enchantress, heal me, deliver me from all evil, bad typhonic things, from demoniacal and deadly diseases and pollutions of all sorts that rush upon me, as thou didst deliver and release thy son Horus! As I have penetrated into the fire, and have emerged from the water, may I not fall into the snare of the day when I shall say: Little am I and Piteous! Oh Ra, thou who hast spoken for thy body! Oh Osiris, thou who prayest for thy manifestation, deliver me from all possible evil, from bad, wicked, typhonic things, from demoniacal and deadly fevers of every sort.

SO MANY CHAPTERS THERE ARE TO SAY
AS IT IS TO BE A THOUSAND TIMES"

The text that follows may be classified under general headings dealing with bites and stings, with the heart and circulatory system, with the morbid conditions of the alimentary and urinary tracts, with obstetrics and gynæcology, with the skin, teeth, and eyes. The final section is concerned with matters less strictly medical, such as cosmetics, a charm against fleas and mice, a remedy for sweaty feet, and so on.

The ingredients range from familiar substances such as castor oil to fantastic concoctions such as excrement of the gods. The aim of the physician seems to have been to produce an effect that might be called physiologically dramatic. The patient could seldom complain that when he took the medicine nothing happened, for in most cases he must either have vomited or had diarrhoea, and in the violence of these reactions his specific complaint may sometimes have been forgotten. A few examples give an idea of what the patient, and the devil afflicting the patient, might expect.

"Remedy to clear out the body and to get rid of the excrement in the body of a person:
Berries of the castor oil tree 1
Chew, and swallow down with beer in order to clear out all that is in the body."

"Another to drive out the stercoral masses in the body
Figs 1/8
Sebesten 1/8
Grapes 1/16

Caraway 1/64
Resin of Acanthus 1/32
Writing fluid 1/64
Peppermint 1/32
Gengent beans 1/8
Sweet beer
Keep moist and take for four days."

"Half an onion mixed with froth of beer for constipations. This is also a delightful remedy against death."

Both beer and onions were favourite remedies. The beer might be warm or cold, sweet or bitter, flat or plain; even yeast of beer and froth of beer had their uses. The onion seems to have been taken over from mimetic magic, and, from dramatically representing diseases or devil, had come to be an item in a prescription—an item of importance, however, when it composed the delightful remedy quoted above.

Constipation seems to have been a frequent complaint in Egypt, which suggests that medicine was mainly concerned with the overfed and inactive. That diarrhoea, in a waterside community overrun with flies, was also a common symptom is not at all surprising, and the cure for it, except for a little charm at the end, is very similar:

"Figs 1/8
Grapes 1/8
Bread dough 1/32
Pit corn 1/32
Fresh lead earth 1/64
Onions 1/32
Elderberry 1/8

Sing O Hetu!
Again O Hetu!"

Here the onion takes a very subsidiary place, and we are led to believe that it was the froth of beer that kept death at bay. When the onion is mixed with 6/7 of a pint of water (the measure of the Hunnu or Henu glass) it is merely a modest remedy for indigestion, as the following recipe shows:

> "Green onions
> Put in water in a new hunnu glass and take for four days."

An external remedy for the same complaint seems to aim at persuading the invading demon to take his departure from a habitation rendered obnoxious:

> "Another to drive out the hardening in the abdomen
> Bread of the zizyphus lotus 1
> Cat's dung 1
> Red lead 1
> Water melon 1
> Sweet beer 1
> Wine 1
> Make into one and apply as a plaster."

Anyone who has cleared up after a badly brought-up kitten would probably decide to stick to the disease rather than the plaster.

Wounds, burns, splinters, and scabs are treated in such a way that it is a wonder that any patient escaped septicæmia:

> "Another remedy to dress a wound
> Human excrement
> Crush in the yeast of sweet beer, sefet oil and honey, and apply as a poultice."

> "To prevent burn wounds
> A frog
> Warm in oil and rub therewith."

"What to do to draw out splinters in the flesh:
Worm's blood, cook and crush in oil
Mole, kill, cook, and drain in oil
Ass's dung, mix in fresh milk
Apply to the opening.

Scabs:
A hog's tooth
Cat's dung
Dog's dung
Aau of samu oil
Berries of the Ket plant
Pound and apply as a poultice."

There seems little to choose between these concoctions and the witches' brew in *Macbeth*, though the end in view was morally superior.

When the ancient Egyptian suffered from an unsteady hand the gods must have trodden the earth in homely form—perhaps Osiris visited the temple precincts in the shape of an ox, or Ra hovered above in the shape of a hawk to assist the physician.

"To drive away tremblings in the fingers:
Incense
Caraway
Wax
Red lead
Excrement of the gods
Honey
Figs
Fresh lead earth
Cook into one and apply as a poultice."

Another prescription for trembling gives directions for the patient to be wrapped in the hide of a dog. It is a type of remedy that has persisted in folk medicine almost until the present time, and it is also a feature of folk dances of very ancient origin, for example the horn dance of Abbots Bromley in Staffordshire. The custom probably began as a totemistic rite, or as the assumption of the virtue or personality of the sacrificial animal that had become identified with the god. These prescriptions show little advance on the most primitive practice. When we come to directions for the examination of the patient, however, we see that the art of medicine as well as the craft of surgery, is slowly developing. The physician palpates the abdomen, and in doing so looks for definite signs. His treatment may be as ineffectual as ever, but at least he is concentrating his attention not on the gods who sent the disease, but on the disease itself, as the following extracts show:

> "When thou examinest a person with a hardness in his left side, and he has feet that he cannot walk with, then say thou: 'He has dug sandbags and lifted sand.' Prepare the remedy that is mentioned before . . .
>
> When thou examinest a person who is ill in his abdomen and all his limbs are heavy like a person who goes to lie down, lay thy hands on his abdomen. If thou findest that his abdomen is swollen and that it comes and goes under thy fingers, then say thou: 'The fault lies in the digestion of his food.' Do not let him eat. Prepare a radical purge for him: Refuse of beer. Dissolve in flat beer. Afterwards let him go and eat his bread. If thou examinest him after this has come to pass, and thou findest the small of his back warm and his body cool, then say thou: 'The fault in the emptying of the bowel has cleared up.' Let him guard his mouth against everything hot.
>
> When thou examinest a person and then findest that he is not in a condition to leap the Nile, his stomach is swollen and his chest asthmatic, then the remedy is:
>
> Refuse of dates
> Fruit of the dom palm

> Oil
> Honey
> Wormwood
> Man's semen."

Directions for diagnosing tumours are practical and rational:

> "When thou meetest a tumour of the flesh in any part of the body of a person, and thou findest it like hide in his flesh, he is clammy, it goes and comes under thy finger, except when the finger is kept still, because the matter escapes through it, then thou sayest, 'It is a tumour of the flesh. I will treat the disease. I will try to heal it with fire, like cautery heals.'
>
> When thou meetest a tumour that has attacked a vessel, it has formed a tumour in his body when thy finger examines it and it is hard like a hard stone under thy fingers, then say thou, 'It is a tumour of the vessels. I will treat the disease with the knife'.
>
> When thou meetest a pustular tumour in the limb of a person, and if, in palpitating it, thou findest that it goes and comes and that the flesh thereunder is drawn over, then say thou, 'A gathering of pustules.' Use the knife against it."

In the section on the heart we find the physician feeling the patient's pulse, and it almost appears, when he writes of the vessels of the heart running to all his limbs, that he has an inkling of the circulation of the blood. But the clue is quickly lost, and, although there is observational support for the theory that the breath passes into the intestines, we feel that the physician is being dogmatic on subjects of which he knows very little. Some of this section, however, is well worth quoting. It begins:

> "The science of the action of the heart, and of the heart itself.

> In the heart are the vessels to the whole of the body. As to these every physician, every sextet priest, every magician will feel them when he lays his finger on the head, on the back of the head, on the hands, on the stomach region, on the arms, on the legs. Everywhere he feels his heart because its vessels run to all his limbs. . . When the breath goes into the nose it makes its way to the heart and intestines and the last-named vessels give to the body richly thereof. . . .
>
> When the heart is sad, behold it is the moroseness of the heart, or the vessels of the heart are closed up in so far as they are not recognisable under thy hand. They grow full of air and water.
>
> When the heart is sick, behold there is an oppression of the heart, or it is an overflow of blood which arises in the heart. It falls down and approaches the diaphragm, while his heart feels an aversion.
>
> When his heart is in the right place the fat of the heart is on the left side. It neither rises upwards nor falls downwards. It remains soundly in its place. When the flesh is quite withered like the stilled heart of a person who has found the way, behold it is his flesh which has become immovable under it like the immovable flesh of a person who has gone into the wide. When it is fate that he shall go up on high, behold it is his heart which determines that he shall go up on high."

Here we have the belief in the heart as the source and arbiter of life, and a view of death as an enlargement, to 'find the way', to 'go into the wide', to 'go upon high'. It is an answer to man's restless seeking that has been repeated down the ages. Surely on such a lofty note the book should end. But no. The writer can be lofty, but he can also be tenderly human. Whatever man's destiny, he is but man, and he has always rebelled against encroaching age and increasing baldness. The writer has comfort for him. Linseed crushed in oil, fat of lion, fat of hippopotamus, fat of crocodile, cat, serpent, Egyptian goat, even, if he can better bear the smell than the baldness, castor oil may give him relief. Before he has sampled all the remedies he has probably grown too old to care.

Then there is woman, yearning for her vanishing youth. Against wrinkles she must use:

> "Incense cake
> Wax
> Fresh olive oil
> Cyperus
> Crush, grind, put in fresh milk and apply to the face for six days.
> See to it."

And no doubt she did. Unless, that is, she preferred an alternative remedy:

> "To make the face smooth
> Cake meal in well water
> After she has washed her face daily let her anoint her face with it."

And lest maternal cares should interrupt her beauty treatment the writer adds a

> "Remedy to stop the crying of a child
> Pods of the poppy plant
> Fly-dirt-which-is-on-the-wall
> Make into one, strain, and take for four days
> It acts at once."

And is probably the only remedy ever discovered that does, but whether at the beginning or the end of the four days the writer does not tell us.

The whole papyrus is interesting as well as amusing, and whilst we can smile at the writer's simplicity we can also wonder that he has already learnt so much. His contemporaries had not yet invented the wheel—in a riverside community the problem of transport was more easily solved by means of boats—but he has had the superb intelligence to communicate by means of writing, and by this means he speaks to us across nearly four thousand years of time, and gives us a picture of the physician-priest-magician to whose care the sick were entrusted. For he was already more than priest and magician. He was not merely playing games to outwit gods and devils. he was examining his patient with care and a sense of responsibility. He felt his pulse, palpated his abdomen, he used his powers of observation. He already regarded disease as something specific that could be classified. In such phrases as 'feet that he cannot walk with', 'his limbs are heavy like a person who goes to lie down', 'he is not in a condition to leap the Nile' it is possible to detect a note of sympathy and understanding. This is not the medicine man who is a terror to man and devil. It is already a faint foreshadowing of the friendly G.P. with his "Well, Mrs. Smith, how are we today? Not feeling like setting the Thames on fire just yet?"

CHAPTER THREE

The Divine Old Man

> "*And by these means and helps, the excellent Hippocrates arrived at the top of physick, who laid this solid foundation for building the Art of Physick upon: viz.* NATURE CURES DISEASES."
>
> (THOMAS SYDENHAM, translated by
> JOHN PECHY, M.D.,

DARK uncounted years stretch between the medicine man's first attempts to drive disease from his devil-haunted patients and the Egyptian doctor's practical and not unsympathetic observation of the devil's works. As gods and devils gradually receded into the background the function of the doctor began to change. He could no longer pose as a mediator, as a magician he was losing caste; if he was to be anything he must become a healer in his own right. Since he could no longer depend on the supernatural he must depend on nature, and because nature cannot, like gods and devils, be bribed or duped, he must, in all humility, try to learn something of her operations. He ceased to be religious, but, bit by bit, he was becoming ethical.

About a thousand years elapsed between the transcription of the Ebers Papyrus by some unknown Egyptian and the composition by some high-minded Greek of the indentures that we know as the Hippocratic Oath. Whether these indentures applied to an individual contract, or whether, as seems more likely, they expressed the conditions on which students of the Hippocratic school were accepted, is not certain. What is certain is that the oath embodied a moral code that remains today the foundation of medical ethics. In the translation by W. H. S. Jones it runs:

> "I swear by Apollo Physician, by Asclepius, by Health, by Panacea and by all the gods and goddesses, making them my witnesses, that I will carry out according to my ability and judgment this oath and this written indenture. *To hold my teacher in this art equal to my own parents;* to make him partner in my livelihood; when he is in need of money to share mine with him; to consider his family as my own brothers, and to teach them this Art, if they want to learn it, without fee or indenture; to impart it by precept, oral instruction and all other instruction to my own sons, the sons of my teacher, and to indentured pupils who have taken the physician's oath, but to nobody else.
>
> I will use treatment to help the sick according to my ability and judgment, but never with a view to injury or wrong-doing. Neither will I administer a poison to anybody when asked to do so, nor will I suggest such a course. Similarly I will not give to a woman a pessary to cause abortion. But I will keep pure and holy both my life and my art. I will not use the knife, not even, verily, on sufferers from the stone, but I will give place to such as are craftsmen therein.
>
> Into whatsoever houses I enter I will enter to help the sick, and I will abstain from all intentional wrong-doing and harm, especially from abusing the bodies of man or woman, bond or free. And whatsoever I shall see or hear in the course of my profession as well as outside my profession in my intercourse with men, if it be what should not be published abroad, I will never divulge, holding such things to be holy secrets.
>
> Now if I carry out this oath and break it not may I gain for ever reputation among men for my life and for my art; but if I transgress it and forswear myself may the opposite befall me."

The great leap between medicine man and physician had been made. The difference in character was fundamental, a difference paralleled in nature only by that between the ape and homo sapiens. No single individual could have accomplished such a transition. It must have been the work of countless apparently insignificant but none the less indispensable people, each making some small advance in technique, in outlook, in practice, in sense of responsibility, as the tide creeps imperceptibly up the gently-sloping sand until it is almost full. Then came the final irresistible impulse, and the tide reached its flood in the person of the ideal physician to whom his successors have turned for inspiration for twenty-four centuries.

If Hippocrates himself was indeed the author of any of the writings that bear his name the Oath has first claim to authenticity, but, whether he wrote it or not, it expresses the new spirit that had been infused into the practice of medicine. Of his life we know little, but we are assured by historians that he did exist, and that, in the golden age in which he lived, he occupied a position of eminence.

It was an age of intellectual giants. Among his fellow-countrymen and near contemporaries were Aeschylus and Euripides, Aristophanes and Sophocles, Socrates and Thucydides, Pericles, Pheidias and Praxiteles. The state was being organised, the great dramas were being written, the Parthenon was being built, and Plato, writing shortly after his death, picks upon Hippocrates as one of the wise men of this scintillating time whose opinion is worth listening to.

He was born 460 B.C. on the island of Kos in the Dodecanese, one of an ancient family of physicians who liked to trace their origin back to Asclepius, the physician made god, and to his two sons, Machaon and Podalirius, surgeon-warriors celebrated by Homer in the Iliad. It was an ancestry to boast of, no doubt, but family pride would have been more justified in looking forward, for the flower of the family tree was yet to come. In the medical school presided over by his father and grandfather Hippocrates learnt his medicine "by precept, oral instruction and all other instruction." It included some magic and ritual with sound observation of the patient; emphasis was on regimen and diet, a system calculated to produce athletes and maintain them in good condition rather than to cure the diseased. This connection between medicine and athletics is pointed by the fact that a famous gymnast of the time, Herodicus of Selymbria, is reputed to have been a great friend of Hippocrates. That the Olympic records of the time were insignificant compared with those of today need not trouble us, for since the doctors are not credited with the latter they need not be blamed for the former, and in any case the fame of Greece does not hang solely upon Olympic records.

Hippocrates learnt all that there was to be learnt at the school of Kos, and then set off to see how medicine was practised elsewhere. He travelled extensively, practised in various parts of Greece and Asia Minor, and died at a ripe old age at Larissa in Thessaly. That is all we know of his life, but his name was stamped so indelibly on Greek medicine that when an enlightened Roman ruler of Egypt, Ptolemy Philadelphus, made a collection of medical writings for his newly-founded library at Alexandria it became known as the Hippocratic Corpus. It is evident, however, that the documents are not all by the same hand, for they are far from consistent in the views they take. Some appear to be earlier, and some later than the time of Hippocrates, and it is not even certain that he wrote any one of them. But in spite of this uncertainty—which is, after all, unimportant—there emerges a clear picture of the practice of medicine in Greece round about the fourth century B.C., and within this picture is an outline of a standard of practice that was not to be equalled again for centuries to come, perhaps not until Thomas Sydenham studied the writings and founded his own practice upon what he learned.

Associated with the name of Hippocrates in the authorship of the papers is that of his son-in-law Polybus, and to him the two treatises on 'The Nature of the Bones' and 'On the Nature of Man' are usually attributed. There are seventy-six treatises in all, and several excellent translations have been made. The *quotations* given below are by W. H. S. Jones and E. T. Withington in the Loeb edition of the classics, which prints the Greek side by side with the English. It is hoped that the excerpts will send the reader off post-haste to read the writings in full.

Some passages are nearly as often quoted and misquoted as lines from *Hamlet* or texts from the Bible, and with equal vagueness as to their source. Most of the following will strike a familiar note:

From Section One of the 'Aphorisms'.

"*Aphorism I.* Life is short, the Art is long, opportunity fleeting, experience treacherous, judgment difficult.

Aphorism III. In athletes a perfect condition that is at its highest pitch is treacherous. Such conditions cannot remain the same or be at rest, and change for the better being impossible, the only possible change is for the worse.

Aphorism XIII. Old men endure fasting most easily, then men of middle age, youths very badly, and worst of all children, especially those of a liveliness greater than the ordinary.

Aphorism XIV. Old men have little innate heat, and for this reason they need but little fuel; much fuel puts it out.

Aphorism XX. Do not disturb a patient either during or just after a crisis, and try no experiments, neither with purges nor with irritants, but leave him alone."

From Section Two.

"*Aphorism V.* Spontaneous weariness indicates disease.

Aphorism XVI. When on a starvation diet a patient should not be fatigued.

Aphorism XXI. Strong drink dispels hunger.

Aphorism XLIV. Those who are constitutionally very fat are more apt to die quickly than those who are thin."

From Section Seven.

"*Aphorism LXXXVII.* Those diseases that medicines do not cure are cured by the knife. Those that the knife does not cure are cured by fire. Those that fire does not cure must be considered incurable."

The treatise on 'Ancient Medicine' contains some shrewd comfort for the newly-qualified practitioner, still appalled at the magnitude of the responsibilities he has undertaken:

> "Wherefore it is laborious to make knowledge so exact that only small mistakes are made here and there. And that physician who makes only small mistakes would win my hearty praise. Perfectly exact truth is but rarely to be seen. For the most physicians seem to me to be in the same case as bad pilots; the mistakes of the latter are unnoticed so long as they are steering in a calm, but when a great storm overtakes them with a violent gale, all men realise clearly then that it is their ignorance and blundering which have lost the ship. So also when the bad physicians, who compromise the great majority, treat men who are suffering from no serious complaint, so that the greatest blunders would not affect them seriously—such illnesses occur very often, being far more common than serious disease—they are not shown up in their true colours to laymen if their errors are confined to such cases; but when they meet with a severe, violent and dangerous illness, then it is that their errors and want of skill are manifest to all. The punishment of the impostor, whether sailor or doctor, is not postponed, but follows speedily."

The punishment referred to is not loss of hand or life, for the doctor as well as the patient is more humanely treated than in the time of Hammurabi, but the loss of prestige, which the Hippocratic writers treat with a disarming frankness now out of fashion. The author of 'Ancient Medicine' is not always behind the times, however, as the following passage, which might almost have been taken from a lecture on the taking of case histories, will show:

> "Since this at least I think a physician must know, and be at great pains to know, about natural science, if he is going to perform aught of his duty, what man is in relation to food and drinks and habits generally, and what will be the effects on each individual."

Pursuing the subject of diagnosis the writer recognises types that are subject to characteristic diseases:

> "There are many other structural forms both internal and external which differ widely from one another with regard to the experiences of the patient and of a healthy subject; such as, whether the head be large or small, the neck thin or thick, long or short; the bowels long or round; the chest and ribs broad or narrow. . . . If a man can in this way conduct with success inquiries outside the human body he will always be able to select the best possible treatment. And the best is always that which is farthest removed from the unsuitable."

This may not be exactly the patient's view, for—with the exception of hysterical subjects, who do not always want to be cured—he would doubtless define the best treatment as that which promotes a rapid cure. But the Greek physician was a realist and was ready to face a fact the patient still finds hard to accept, namely that there are diseases for which no remedy is known, and these can be treated only in such a way as to make the symptoms more bearable.

The section on 'Prognosis', contains some subtle wisdom, familiar enough to the quack, who, having little to offer, must rely on faith, and on the personal impression he makes on the patient:

> "I hold that it is an excellent thing for a physician to practise forecasting. For if he discover and declare unaided by the side of his patients the present, and the past and the future, and fill in the gaps in the account given by the sick he will be the more believed to understand the cases, so that men will confidently entrust themselves to him for treatment. Furthermore, he will carry out the treatment best if he know beforehand from the present symptoms what will take place later. Now to restore every patient to health is impossible. To do so indeed would have been better even than forecasting the future."

as most patients would emphatically agree.

In the section on 'Epidemics' there is an odd, disconnected paragraph which gives sounder advice, and raises the speculation as to how much medical literature was available at this period. The passage runs:

> "The power to study correctly what has been written I consider to be an important part of the art of medicine. The man who has learnt these things and uses them will not make great mistakes in the art."

The Hippocratic Corpus contains a long treatise on 'Airs, Waters and Places', which apparently played an important part in Greek medicine, as they continued to do for many centuries. Portia warned Brutus against 'the humours of the dank morning'; until well on into the nineteenth century malaria was attributed to the bad air (mal aria) that haunted marshy places rather than to the mosquitoes that bred in them; and even today, though for very different reasons, the situation of a sanatorium is chosen with care. According to the Greek writer there is danger in the changes of the year, the rising of the stars, the setting of the Pleiades; autumn is the more sinister of the equinoxes, summer of the solstices. The physician had to be weather-conscious. We can picture him studying whatever served him for weather glass—sea-weed or pine cone maybe—and making notes of the prevailing winds, for such things were important diagnostic aids. He was taught that:

> "he ought to consider what effects each season of the year can produce. For the seasons are not all alike; but differ widely both in themselves and in their changes. The next point is the hot winds and the cold, especially those that are universal, but also those that are peculiar to each particular region. He must also consider the properties of the waters; for these differ in taste and in weight, so the property of each is far different from any other."

The situation of a city was considered of the utmost importance to health. It was a grave mistake to choose a dwelling exposed to hot winds—"these are those between the winter rising of the sun and of its winter setting." Of the inhabitants of a city so placed the writer says:

> "Most of them have a rather flabby physique, and they are poor eaters and poor drinkers. For men with weak heads will be poor drinkers, as the after effects are more distressing to them."

Endemic diseases will be a characteristic of the neighbourhood, a large proportion of women will be sterile, many will miscarry, children will be subject to asthma and convulsions, men to diarrhoea, dysentery, ague, long-continued winter fevers, frequent nocturnal irritation and anal hæmorrhoids.

Perhaps it is dysentery that supplies the key to this catalogue of misfortunes, and the key to dysentery is not south winds but water supply, which, unfortunately, cannot be judged by taste and weight. Although water supply does play a part in the situation of the ideal city, it is a very minor one:

> "Those that lie towards the rising of the sun are likely to be healthier than those facing the north and those exposed to the hot winds, though they be but a furlong apart. In the first place the heat and the cold are more moderate. Then the waters that face the risings of the sun, must be clear, sweet-smelling, soft and delightful in such a city. For the sun, shining down upon them when it rises, purifies them by dispersing the haze which usually prevails at dawn . . . . The persons of the inhabitants are of a better complexion, more blooming than elsewhere. . . . They are clear-voiced, and with better temper and intelligence than those who are exposed to the north, just as all things growing there are better. A city so situated is just like spring because the heat and cold are tempered; the diseases, while resembling those which we said occur in cities facing the hot winds, are both fewer and less severe."

This description brings to mind the island valley of Avilion,

> "Where falls nor rain nor hail nor any snow,
> Nor any wind blows loudly."

and belief in it is of the fancy rather than of judgment. Yet some foundation in fact there must have been. Perhaps the old Greek was arguing from the particular to the general, an error still committed occasionally.

We follow him with firmer conviction when he deals with the effect of climate on national characteristics. It must be remembered that in speaking of Asiatics he is not thinking of India or China, of which his knowledge was no more than hearsay, but of Asia Minor, a region under Greek influence, in which Hippocrates had travelled widely. The section has been much quoted. Here one quotation must serve to whet the appetite:

> "With regard to the lack of spirit and courage among the

> inhabitants, the chief reason why the Asiatics are less warlike and more gentle in character than Europeans is the uniformity of the seasons which show no violent changes either towards heat or towards cold, but are equable. For there occur no mental shocks, nor violent physical changes which are more likely to steel the temper and impart to it a fierce passion than is a monotonous sameness. For it is changes of all things that rouse the temper of man and prevent its stagnation. For these reasons, I think, Asiatics are feeble. Their institutions are a contributory cause, the greater part of Asia being governed by kings. Now where men are not their own masters and independent, but are ruled by despots, they are not keen on military efficiency, but on not appearing warlike. . . . For the risks they run are not similar. Subjects are likely to be forced to undergo military service, fatigue and death, in order to benefit their masters. . . . All their worthy, brave deeds merely serve to aggrandise and raise up their lords, while the harvest they themselves reap is danger and death."

Then, as now, health depended on a delicate balance between man and his environment, which included, according to the Greek, not only locality and weather, but also food, habits, exercise, and even government, as the proletarian governments would no doubt enthusiastically agree.

And then, as now, there were differences of opinion about diet:

> "Some benefit by taking one meal only each day, and because of this benefit they make a rule of having only one meal; others again, because of the same reason, that they are benefited thereby, take lunch also. Moreover, some have adopted one or other of these two practices for the sake of pleasure or for some other chance reason. For the great majority of men can follow indifferently

> either the one habit or the other, and can take lunch or only one daily meal. Others again, if they were to do anything outside what is beneficial, would not get off easily, but if they change their respective ways for a single day, they suffer excessive discomfort. Some, who lunch although lunch does not suit them, forthwith become heavy and sluggish in body and mind, a prey to yawning, drowsiness and thirst; while, if they go on to eat dinner as well, flatulence follows with colic and violent diarrhoea. . . . On the other hand, if a man who has grown accustomed, and has found it beneficial, to take lunch, should miss taking it, he suffers as soon as the lunch hour is passed from prostrating weakness, trembling and faintness."

This is a convincing argument in favour of letting patients do as they please in the matter of food, and upholds those who insist that they 'get indigestion' if they do otherwise, a complaint every doctor must hear until he wearies of it. The writer goes on to state the modern view that the metabolic rate varies in different people.

Even at their lowest level the Hippocratic writings are never dull, and when they seem to have strayed farthest in the doubtful realm of speculation return suddenly to fact with some shrewd piece of observation that has the freshness of a truth discovered yesterday. The description of the 'Facies Hippocratica', the dying face, in 'Prognosis' is still quoted to the medical student, for in more than two thousand years of medicine it has not been improved upon. All who have ever looked upon the shadow that death casts before will recognise its truth:

> "First he must examine the face of the patient, and see whether it is like the faces of healthy people, and especially whether it is like its usual self. Such likeness will be the best sign and the greatest unlikeness will be the most

> dangerous sign. The latter will be as follows. Nose sharp, eyes hollow, temple sunken, ears cold and contracted with their lobes turned outwards, the skin about the face hard and tense and parched, the colour of the face as a whole being yellow or black. . . . But if, along with one of the other symptoms, eyelid, lip or nose be bent or livid, you must know that death is close at hand. In acute fevers, pneumonias, phrenitis and headache, if (the hands) be moved before the face, hunt in the empty air, pluck nap from the bedclothes, pick up bits and snatch chaff from the walls—all these signs are bad, in fact deadly."

This passage recalls that other famous passage in which Mistress Quickly describes the dying Falstaff: "After I saw him fumble with the sheets, and play with flowers, and smile upon his fingers' ends, I knew there was but one way; for his nose was as sharp as a pen . . ."

To the physician probably the most interesting section of the writings is that in 'Epidemics' which describes forty-two case histories in terms so accurate and honest that they might almost be placed among the medical records 'not to be handled by the patient' in any modern hospital. Case histories were not new in Greek medicine. The temples of Asclepius, as the files of any present-day quack, were well stocked with stories of seeming miracles and fantastic cures. Such stories seldom, if ever, recount the failures by which the successes might be judged. The forty-two cases in the 'Epidemics,' on the other hand, record twenty-five deaths. There is no miracle here, and every carefully-recorded fact carries its own conviction. The physician reading them, is tempted to make his own diagnosis and to speculate on the prevalent diseases of ancient Greece. For the layman the case histories are intimate historical documents, which bring to life, in a special sense, people dead in ages long ago. The very names have a suggestion of nearness.

> "Philiscus lived by the wall. He took to his bed with acute fever on the first day, and sweating; night uncomfortable . . . about midday on the sixth day the patient died."

> "Silenus lived in Broadway near the place of Eualcidas."

> "In Thasos the wife of Philinus gave birth to a daughter"

and died, probably of puerperal fever. But the wife of Epicrates, who also give birth to a daughter, had a complete crisis on the eighteenth day, and the fever ceased, a long illness with a happy ending.

The sections on surgery, comprising 'Wounds in the Head', 'In the Surgery', and 'Fractures and Joints' are of paramount interest to the surgeon, though they are not without attraction for the layman. It has already been remarked that surgery of some kind has always been a necessity amongst warlike people, and in addition to wounds and common accidents the Greek surgeon had to deal with the injuries incurred by athletes. Each gymnasium had its own surgeon skilled in the reduction of dislocations and fractures. It was a different profession from that of physician, and in view of the undertaking in the Hippocratic Oath it seems unlikely that both professions were practised by Hippocrates himself, at any rate at the same time, though the evidence is too scanty to rule out the possibility altogether. Until modern times surgery was regarded more as a craft than as an art, and the skill required was dexterous rather than intellectual. Nevertheless, as described in the Hippocratic writings, it must have been of a much higher standard than that attained by the barber-surgeons and itinerant lithotomists of the Middle Ages. Tar was used for dressing wounds, an infusion of mandragora, benzoin and henbane drugged, if it did not anæsthetise, the patient. The surgeon was instructed to keep his nails clean and short, "neither to exceed nor come short of the finger-tips", and to "practise all the operations with each hand, and with both together."

Instead of giving excerpts from several cases one of them will be quoted in full, for it illustrates vividly both what the patient had to endure and the care taken that he should not suffer unnecessarily. It comes from 'The Treatise on Joints' and follows a careful description of four possible dislocations of the hip, in which the remarkable statement is made that dislocation inward, a most rare condition nowadays, was more common than dislocation outward. The only explanation that appears acceptable is that this was due to some particularly violent throw or hold in wrestling.

The reduction of the dislocation is described as follows:

> "It is a good and correct method, and in accordance with nature, and one, too, that has something striking about it which pleases a dilettante in such matters. One should suspend the patient by his feet from a cross-beam, with a band, strong, but soft and of good breadth. The feet should be about four fingers apart or even less. He should be bound round above the knee-caps with a broad soft band, stretching up to the beam, and the injured leg should be extended about two fingers' breadth further than the other. Let the head be about two cubits, more or less, from the ground. The patient should have his arms extended along his sides and fastened with something soft. Let all these preparations be made while he is lying on his back, that the period of suspension may be short as possible. When he is suspended let an assistant who is skilful and no weakling insert his forearm between the patient's thighs and bring it down between the perinaeum and the head of the dislocated bone. Then, clasping the inserted hand with the other while standing erect beside the suspended patient, let him suddenly suspend himself from him and keep himself in the air as evenly balanced as possible. This mode of reduction provides everything requisite according to nature; for the body itself when suspended makes extension by its

> own weight; the assistant who is suspended, while making extension, forces the head of the bone to a position above the socket and at the same time levers it out with the bone of his forearm, and makes it slip into its old natural place. The bandages must be perfectly arranged and care taken that the suspended assistant is the strongest available."

In this description of the patient, enduring, as he must, agonies of pain whilst the surgeon strives, with some pleasure in his own display, to make him sound again, a link can be discerned between primitive man, who accepted pain and catastrophe as his natural lot, and modern man, who seeks the utopia of physical well-being.

In medicine the Hippocratic physician was just such a link. Where acute conditions were concerned he could do little. He had few remedies at his command; barley gruel or honey and vinegar seemed as likely to be of use as anything else. Pain must be endured. There was no merciful oblivion in anæsthetics, no anti-toxins, no bactericides. The physician's task, as he saw it, was to recognise disease, to distinguish between a mild disorder and a serious illness, and to wait on nature and trust the *vis medicatrix naturae*, the body's tendency to produce its own healing organisms. But as he waited he watched. He made notes for his own future guidance and that of others. He made the patient as comfortable as he could and did not try his fortitude unnecessarily. He gave him sympathy and a considerable degree of understanding. It was long ages before he was again in a position to do as much.

CHAPTER FOUR

Public Health and Hospitals

"*A greatter nombre of poore nedy sykke and indygent persones shalbe refresshed maynteyned comforted fow2nde heled and cured of theyre infyrmytyes frankly and frely, by phisicions, surgeons, and appotycaryes.*"

(from the Petition of the LORD MAYOR and CITIZENS OF LONDON to KING HENRY THE EIGHTH)

THE early blossoming of Greek medicine, reaching its fullest development with Hippocrates, met the frost of Roman conquest before it had borne sufficient fruit to prove its usefulness. The Romans were a practical people, and the only science they respected was the science that could be put to immediate use and show results. The case histories of Hippocrates, with their sixty per cent death rate, were not the kind of results to impress them. It seemed to them that the pater familias, equipped with a little common sense and a reasonable amount of good luck, might do equally well.

Nor was early Christian influence directly helpful to the progress of medicine. A handful of enthusiasts awaiting hourly the coming of the millennium were not likely to take a lively interest in such a slow process as the conquest of disease. If the sick died the resurrection would be upon them shortly and they would have a place in the Kingdom with the poor in spirit and them that mourn. But as time went by and they became less preoccupied with the end of the world, the characteristic Christian ethic began to assert itself. They had been enjoined by precept and example to heal the sick, cleanse the leper, raise the dead; to visit the suffering was to visit the Master himself and a prerequisite for Paradise. Gradually the care of the sick became an integral part of Christian responsibility.

Unfortunately they had inherited, possibly from the time of the Jewish captivity in Babylon, the tradition that attributed disease to possession by devils. They were inclined to regard it as a punishment for sin. As a result much of their treatment consisted of exorcisms, prayer and fasting, and the laying on of hands. They believed that the state of the body depended on the condition of the soul, and not, as we are more inclined to think nowadays, that the condition of the soul is influenced by the state of the body—an assumption more stimulating to scientific medicine.

As the power of the Empire declined and that of the Church increased, yet another factor came to have an influence on the development of medicine, that of authority. It is not surprising that the Christians, who had been stigmatised as barbarians, should be unsure of themselves intellectually, and it is a truism of psychology that lack of self-confidence breeds dogmatism. Very early in its history the Church developed a habit of laying down the law, not only on matters of religion and ethics, but also on matters less legitimately within its province, such as scientific discovery and medical practice. The medical profession was itself tentative and uncertain, and when the Church accepted Galen and Aristotle as the final authorities on matters medical the profession was content to acquiesce, having at the time nothing better to offer.

Both Galen and Aristotle had the scientific spirit. Much of what they observed and recorded holds good today, but, like all scientists, they were fallible and made mistakes, which they themselves, had they had the opportunity, would have been the first to recognise and correct. Unfortunately it was not their scientific spirit, which would have led to further progress, that was cherished, but their voluminous writings, available in Latin at a time when Greek was neglected and half forgotten. Unproved concepts were accepted as proved, together with observations that were accurate and fruitful. Galen's anatomy, accurate for the Barbary ape from which it was derived, was accepted as equally valid for man; Aristotle's doctrine of the four elements became the corner-stone of physics, and the four humours the corner-stone of medicine. It was safer for the scientist to doubt his own senses than to doubt authority, and the smoke and smouldering fires of the stake began to confuse the path of scientific discovery.

But in spite of the contempt of the Roman, the mysticism of the Christian, and the dogmatism of the Church, discoveries were made and knowledge was accumulated, even in the dark ages; medical schools were founded, the responsibility of government for some measure of public health was acknowledged, and a hospital system came into being that was eventually to become the glory of the civilised world.

Medical schools of a kind had already existed in Greece. They resembled schools of painting rather than the more regularly organised colleges. The successful physician gathered round him a number of young enthusiasts who observed his methods, and discussed cases and treatment with him. They accompanied him on his 'rounds', and helped him in his surgery, the *iatreia*, which was the private property of the doctor.

But the doctor throughout history has had his social ups and downs, and under the Romans his status was very low indeed. He was in fact a slave. "The dignity of the Roman" wrote Pliny in the first century A.D. "does not permit him to make a profession of medicine, and the few Romans who begin to study it are venal renegades to the Greeks." So the dignified Roman imported slave-physicians from Greece, and gave them the title of *medicus*. It was not at the time an honourable or even a very precise title. A thousand years later, in 1276, we can still read in the chronicles of the spital of St. Leonards of Ann Medica, who was probably no more than an attendant on the sick.

The Greek *medicus* was bought and sold in the market like any other slave; his price, as fixed by the Code of Justinian, was sixty *solidi*, about sixty pounds in the days of golden sovereigns. In the Roman household his status was probably a little higher than the valet but doubtless lower than the cook. Whether he was reliable or efficient is open to doubt. He must occasionally have been irresistibly tempted to lower the dignity of the contemptuous Roman with a scouring purgative or nauseating emetic. It is not surprising that the pater familias, who held himself responsible for the health of his household, often preferred to do his own doctoring, and regarded the agile-minded Greek much as, in later times, the 'huntin', shootin' and fishin' ' squire regarded any intellectual achievement that would not help him over a five-barred gate.

The slave-physician was hardly in a position to lead a school, but his Roman master, for his own advantage and that of his household, had him educated in his profession. Gradually his status improved. Julius Cæsar, realising the great need of physicians in Rome, where the population at that time must have numbered about half a million, made all physicians practising in the capital citizens of the Roman Empire. He may have been influenced in the matter by his own physician, Antonius Musa, and when, in the violent course of palace politics, Musa became court physician to his nephew Augustus, the position of the physician was still further improved by exemption from taxation. (The doctor of today will have his own reasons for calling this period 'The Golden Age.') Tiberius (A.D. 14-37) and Nero (A.D. 54-68) still further increased the doctor's prestige, and Nero's tutor, Seneca, could write, "People pay the doctor for his trouble, for his kindness they still remain in his debt", an appreciation indicative of considerable respect.

Meanwhile medical education was slowly taking shape. Asclepiades of Bithynia, who died about 40 B.C., had a medical school on the Greek pattern, and took his pupils with him on his 'rounds', a fashion that continued, in spite of the fact that it was not always well received by the patient. A verse of Martial (A.D. 43-104), paraphrased in English, runs:

"I felt a trifle indisposed one day.
Anon comes Symmachus with an array
Of pupils, quite a hundred I should say.
Oh, Symmachus, I was not sick, I vow,
Until their icy fingers felt my brow.
I had no fever then, but I have fever now."

In time the pupils formed themselves into a company or college, and employed a teacher to instruct them. Early in the first century of our era they built themselves a meeting-place on the Esquiline Hill, and called it the Schola Medicorum. Here they debated theories and cases. There was, as there was to be for many years to come, more talk than practice and observation, for the effectual environment for training doctors, namely the hospital, had not yet been invented. But their position continued to improve under the Emperors, and in the reign of Vespasian (A.D. 70-79), who had a serious concern for public health and hygiene, and is credited with the invention of public lavatories, the teachers were already receiving a salary from public funds.

About the same time physicians were appointed by the municipalities with the double responsibility of attending the poor and teaching students. A statute of the Emperor Antoninus regulated their appointment. By this time there were two types of physician, the *archiatrus*, or court physician, and the *archiatrus popularis*, who was a municipal official elected by popular vote. In the army there was a corresponding distinction between the surgeons to the legions and prætorian cohorts, who must be Roman citizens, and those attached to the 'cohorts of the watch', who were freedmen or 'foreigners'.

Under Lucius Septimius Severus (A.D. 193-211) medical practitioners were licensed by, and responsible to, the State, and the Emperor Alexander Severus (A.D. 222-235) appointed special lecture-rooms for the colleges, with salaried lecturers in charge. In the reign of the Emperor Valentinian (A.D. 364-375) Rome was served by an *archiatrus popularis* in each of its fourteen districts; there were also State physicians, physicians for the colleges, for the gymnasia, and even for the Vestal Virgins. All these physicians had to undergo some kind of examination before appointment, and under the system qualified teachers and medical schools increased in number. They spread throughout Italy, and to Marseilles, Arles, Nîmes, Lyons, Benvenutum, Avranches, and even as far as Bordeaux.

As a result of Roman providence the pattern of a secular medical school, with teachers, lecture-rooms and textbooks had come into being, and if it was but a foreshadowing, waiting as yet for clinical material to give it effectual substance, it was at least as good as it could be until, centuries later, it was united with the hospital system.

The Roman pattern served as the plan of the great mediæval school that arose at Salerno during the ninth century and flourished until the thirteenth, when its glory paled before that of Montpellier and Bologna. Early in the twelfth century the school of Salerno was taken under the jurisdiction of King Roger the Second of Sicily, and later under that of the Emperor Frederick the Second. This lay control, though not completely effective, made its mark, and a salutary one, on the regulations. A rule was laid down that no one should begin a medical course until he was twenty-one years of age and had studied logic for three years, the mediæval equivalent of a standard of general education. The medical course must last five years, and no one must practise until he had been examined by the masters. Having passed this examination, no doubt an oral one, he was allowed to take the title of Magister or Doctor, and must take an oath which included an undertaking to attend the poor gratis, to administer no poisonous drug, and to teach nothing false. After a year's work under an experienced practitioner he was allowed to practice medicine independently.

As medical training the curriculum lacked one essential, practical experience, somewhat inadequately supplied by the year of post-graduate work. But such as it was, and it was a magnificent institution, the school of Salerno spread its influence throughout Europe, recognised medicine as a learned profession, provided such teaching as was then available, and was itself the forerunner of the Universities.

It was again Rome, with its genius for organisation, that designed hospitals, in the first place to meet the military needs of its growing Empire. Surgeons were, of course, part of the army system. They were not well paid and their position lacked authority, for they were under the command of combatant officers, and were ranked with clerks and accountants. They treated casualties, when possible, on the spot; others, if they survived, were sent back to Rome. But as the network of the Roman armies spread over the known world, bringing in their wake civilian administrators, treatment of the sick and wounded became a more serious problem than could be dealt with by army surgeons, however well-meaning, and a more elaborate system had to be evolved.

In the ruins of Pompeii there are the remains of buildings that show that the Roman doctor's house was also sometimes a private nursing home, and something of this kind may have been the origin of the 'valetudinaria' that were established in various parts of the Empire for the treatment of casualties. The earliest known example was at Carnatum, near Vienna, and was built in the first century A.D.; another, established by Tiberius at about the same time, has recently been excavated at Novæsium, near Düsseldorf. Their purpose was military, but they may also have provided convenient treatment centres for the many officials and their families on whom the administration of the Empire depended.

It may have been the pattern of the valetudinaria that was seized upon and copied by the early Christians, who, as their wealth and authority developed, founded hospitals, as a Christian duty, in Cæsarea, Rome, Jerusalem, and other centres of Christian influence.

But before tracing further the development of the 'spital' mention should be made of the contribution of Rome to public health. The appalling sanitary condition of large towns in the Middle Ages, and indeed well on into the eighteenth century, is well known—the open drains, the lack of water, the general filth that formed an ideal breeding ground for cholera, typhus, plague, and other epidemic and endemic diseases. Writing in Percy Street, London, in the year 1783, Doctor William Buchan complains, "In many towns the streets are little better than dunghills, being frequently covered with ashes, dung, and nastiness of every kind", and in a later edition of the same work, published in 1807, his son sees no reason to omit the passage. It is interesting to speculate whether such a state would have persisted so long had the Romans not been so utterly defeated by the barbarians.

For in Rome the Cloaca Maxima, the great sewer that is still in use today, was already in existence in the seventh century B.C. Its outlet was directly into the Tiber, and its repair and general cleansing were the work of condemned criminals, a punishment which, though it might not be redemptive, at least went some way to repay the criminal's debt to society. By the time of Furius Camillus (d. 365 B.C.) private drains had been built into the houses, flushed either by rain-water or by water from the aqueducts.

The aqueducts were begun in the fourth century B.C. The Aqua Appia was ten miles long, and was built in 312 B.C., the Aqua Anio Vetus, which was sixty miles long, in 272 B.C. Others were added as the population, and with it the need for water, increased. The quantity per head has been variously estimated. The amount carried by the four largest aqueducts has been calculated as not less and probably more than 1,540,000 gallons per day, and the supply per head per day has been assessed at 300 gallons. Whatever the precise quantity may have been, there is no doubt that the Roman, even according to modern standards, was not short of water. The water supply of London—taken mostly from the Thames by pumps, and anything but clean—was 4 gallons per head per day in

1767. Nowadays 40 gallons per head is considered ample in the capital, whilst many households in the United Kingdom are still dependent on the amount one woman can carry, in the intervals between her other duties, in two buckets from the tap in the yard or the well down the garden.

It is true that Roman water was not in the first instance supplied direct to the dwellings, but the inhabitants were able to help themselves from convenient leaks in the communal pipes, and for this privilege there was a charge. Eventually connections were made with the houses, cisterns and taps were supplied, and reservoirs were built. An adequate water supply can hardly be classed as an advance in medicine, but it is a valuable contribution to public health, and without it medical advance would be severely handicapped.

Many centuries were to pass, however, before Roman genius for organisation, expressing itself in the form of public drainage, public water supply, and public health service, was to be adopted by the barbarians, and the dark ages that followed the fall of Rome were indeed dark so far as medicine was concerned. But hospitals, such as they were, appealing both to the acute Oriental mind of the Arab and to the simple, soul-saving piety of the early Christian, developed and flourished. Probably Arab hospitals were more closely concerned with the observation and study of disease than early Christian hospitals, which were essentially religious in outlook and administration. There were as many as fifty hospitals in Córdova at the turn of the millennium, and those of Bagdad were famous for their comfort and luxury, which included music, an amenity supplied in modern times in the Kurhaus of Germany. During the time of the Crusades the Oriental hospitals had their influence on the Western outlook. The Knights of St. John established a hospital in Rhodes in 1311, and in Malta in 1530, both of which are still in existence, and it was during the twelfth and thirteenth centuries that the first great London hospitals were built.

Most of the early Christian hospitals had been monastic institutions, and their object was primarily pious and philanthropic. A large number of religious houses had a wing or hut set apart where the monks tended their sick, and in addition received and aided sick and needy wayfarers, for the most part pilgrims. The monk's medical skill was limited, for he was strictly forbidden to shed blood, and even the incision of a boil required the services of a layman. The layman worked under the monk-in-charge, and was considered his inferior. The rift which divided the physician from the surgeon, and which had existed to some extent in ancient times, was thus widened, making room for the differentiation, again emphasised by university training, between medicine as a learned profession, with the title of Magister Doctus, and surgery as a craft, with the right only to the title of Mister. Even today it may be noted that in royal processions the Queen's surgeons, however distinguished, are preceded by the Queen's physicians, who inherit the precedence of their ecclesiastical forerunners.

The monks' chief skill, such as it was, was with herbal remedies, and most spitals possessed a herb garden, cultivated by the lay brothers. But the spital was not a hospital in the modern sense of the word. It combined in varying degrees the functions of a hostel, an orphanage, and an almshouse, and in caring for the needy the Brothers were caring primarily for their own souls and for the souls of those they tended.

A spital of this kind existed on the south bank of the Thames before the Norman Conquest. A legend, with no foundation in fact and little in probability, tells how it was founded by a certain Mary, who earned the necessary means by ferrying travellers over the river, and so came to be known as Mary Over-the-river, contracted into Mary Overy. A simpler explanation is that the spital was attached to a foundation situated on the far side of the river from London, and dedicated to the Virgin Mary. Whatever its beginning, its earliest records are of ministering to travellers passing from Winchester, then the capital, to London, a developing trading centre. It was probably little more than a hut where travellers slept, and were cared for, when care was needed, by Augustine Canons, a preaching order whose rule allowed opportunity for other ministrations. "Before all things, dearest Brethren," exhorted their founder, "let God be served, then your neighbour," and both God and neighbour were served at St. Mary's spital.

As London grew and travel became more general the number of those needing care of this kind increased. A two-storey building of oak and thatch was erected, and forty inmates were accommodated. The modern expression 'a hospital of forty beds' is inappropriate, for there were no beds. The patients lay on rushes, and the staff consisted of four Canons, three professed sisters, and a warden, in addition to lay brothers and sisters, who fulfilled the more menial tasks, including those of surgeon and apothecary.

It was this spital that by the time of William the Second had become something in the nature of a hospital, and after the canonisation of Becket in 1173 was renamed St. Thomas's, St. Thomas the Archbishop again giving place to St. Thomas the Apostle with the change in Church politics after the Reformation.

In 1123 the hospital of St. Bartholomew, also under the rule of the Augustine Canons, had been founded in Smithfield by Rahere, Mimus Regis, or Court Minstrel, to Henry the First, a position of some importance, and not to be confused with that of the wandering minstrels or the native English Gleemen who picked up a more precarious living on their travels. A contemporary story tells how the foundation of the hospital was the result of a tearful bargain made between the musician and his Maker when he was overtaken by a grievous illness during a pilgrimage to Jerusalem. The twelfth-century 'Book of the Foundation' recounts how

> "he began to be uexed with greuous sykenesse, and his doloures, litell and litell, takynge ther encrese, he drew to the extremyte of lyf . . . Albrake oute in terys, than he auowyd yf helthe God hym wolde grawnte, that he

> myght lefully returne to his contray he wolde make an hospital yn recreacion of poure men, and to them so there i gaderid necessaries mynystir, after his power."*

Another of London's mediæval spitals was that of St. Mary of Bethlehem in Bishopsgate, which was founded in 1246 as a priory of Canons and Sisters "to receive the Bishop of Bethlehem when he should have occasion to travel thither". At some later period, but before the Reformation, it came to be used for the incarceration, rather than the care, of 'distracted people', who received scant tenderness in those days, for were they not the habitations of devils?

All over Europe spitals were established, founded and supported by gifts and legacies from pious people anxious to come to terms with God and their own souls, and to avoid, if possible, the torments of hell fire. They served as orphanages, almshouses, lying-in hospitals, homes for the aged and infirm, asylums for the sick, the care of the soul always taking precedence of the care of the body.

This was particularly the case in lazar houses, where the excommunication of the leper from all other human society was preceded by a religious service in which the death of the body was mimed, as a preliminary to the everlasting bliss into which the poor soul would eventually succeed. In England alone there were some two hundred of these tragic institutions, an enormous number compared with the size of the population. The question inevitably arises as to whether leprosy was a common disease in the Middle Ages, or whether the larger number of lazar houses must in part be explained by mistaken diagnosis. Skin diseases, in the prevailing filth of the time, must have been legion, and many of them were liable to be mistaken for leprosy, fear turning doubt to certainty.

All these institutions fell on evil days as the failings and abuses that hastened the Reformation crept into the religious houses and multiplied. Many of them, for one reason or another, it might be lack of funds or lack of morals, had closed their doors before Henry the Eighth gave them the *coup de grâce*, and with their dissolution the service they had rendered came to an end. A state of affairs arose that neither the reformers nor those that profited from reform had foreseen. Not only in London, but in London pre-eminently on account of its size, the sick, the destitute, the dying and even the dead lay in the streets untended "to the infection and annoyance of the King's subjects using these streets and places," who, disliking the sight of Lazarus on their doorsteps, were moved by pity and by self-interest to find some remedy for this hideous and annoying state of affairs. Accordingly in 1538 the Mayor and Commonalty of London petitioned Henry the Eighth to hand over hospitals and their considerable possessions to the management of the municipality.

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* "He began to be vexed with grievous sickness, and his pains increasing little by little, he drew near to the end of life. He burst into tears, then vowed that, if God would grant him health so that he might rightly return to his country, he would build a hospital for the rehabilitation of poor men, and minister necessities according to his power to those thus gathered there."

As a result of this petition, which the King was in no great haste to grant, the hospital of St. Bartholomew was transferred to the Lord Mayor and Aldermen in 1544, together with £1000 for initial expenses, and an income of 500 marks (£333) per annum from the Royal purse for its maintenance, an inadequate sum which the citizens eked out with an equal sum from their own pockets. The next spital to return to its former use was that of St. Mary of Bethlehem, and following it, in 1552, St. Thomas's, which was repaired, and its accommodation increased from 40 to 260. The two other Royal hospitals, Christ's and Bridewell, were established at the instigation of Archbishop Ridley, and financed partly from Edward the Sixth's privy purse and partly from funds acquired from the dissolution of the Savoy and Greyfriars. Christ's was established in the old monastery of the Grey Friars as an asylum for fatherless children, and Bridewell as "a house of Correction and Workhouse for the poor—for the strumpet and the idle person, for the rioter that consumeth all, and for the vagabond that will abide in no place."

It will be noted that only two of these institutions gave any treatment to the sick, unless the despairing inmates of Bedlam (St. Mary's of Bethlehem) can be included. A regulation was made at St. Thomas's that pregnant women should not be admitted, on the grounds—the south-of-the-river neighbourhood being what it was—that it was "erected for the use of honest persons and not of harlots."

Conditions were more comfortable than in the early days. Beds had been introduced towards the close of the thirteenth century, when they were occupied, as can be seen in contemporary illustrations, by two or three patients at once, sometimes the dead with the living. In the sixteenth century patients were accommodated in feather beds, a comfort which has since been discontinued. At first the medical staff consisted exclusively of surgeons, but physicians were soon included, and it is recorded that in 1556 Henry Ball was appointed physician of St. Thomas's at a salary of £13. 6s. 8d. per year. There were also apothecaries. In 1621 the appointment, again at St. Thomas's, carried a salary of £45 per annum, but out of this sum drugs had to be provided, so the apothecary was not likely to be better off than the physician. Nursing was carried on by 'sisters' supervised by a matron, and no longer, of course, religious. There may have been some regret that they were not under the restraint of a religious order, for they seem to have caused a good deal of trouble, running to the tavern, brawling, getting drunk, letting hens into the wards, and 'lodging out of the house', all of which practices were strictly forbidden.

But in spite of their imperfections hospitals had come into being where the sick were cared for, where physicians and surgeons could gain experience, and where eventually students and nurses could receive systematic training.

In the London hospitals it became the custom for physicians and surgeons to be accompanied on their visits by their private apprentices. It was even necessary to make regulations whereby these apprentices should be forbidden to usurp the work of their masters. Then informal arrangements were made for the apprentices to take a short course of hospital work under appropriate supervision. The private apprentices became clerks and dressers in the wards, under the authority of the medical staff of the hospital, which assumed the responsibility of teaching and became, in time, a regularly constituted medical faculty. In this advance in medical education St. Bartholomew's was the pioneer, and already in the seventeenth century students were 'walking the hospital.'

But it was not until the eighteenth century that an impetus in hospital building took place that could be compared with the building of the spitals of the Middle Ages. London, starting the century with only the two Royal hospitals, saw the building of the six great voluntary hospitals, Guy's, the Westminster, St. George's (an off-shoot of the Westminster), the London, the Middlesex, and Queen Charlotte's. The movement was widespread. Voluntary hospitals arose all over the country, and in large towns everywhere. Henceforward the advancement of medical science went hand-in-hand with that of the hospital system. And let it not be forgotten that the voluntary hospitals were supported entirely by the public, and that a large part of the work of the physicians and surgeons who staffed them was done for nothing.

CHAPTER FIVE

Doctour of Phisyk

"*With us ther was a Doctour of Phisyk,*
In al this world ne was ther noon him lyk
To speke of phisik and of surgerye;
For he was grounded in astronomye.
He kepte his pacient a ful greet del
In houres, by his magik naturel.
Wel coude he fortunen the ascendent
Of his images for his pacient.
He knew the cause of everich maladye,
Were it of hoot or cold, or moiste, or drye,
And where engendred, and of what humour;
He was a verrey parfit practisour.
The cause y-knowe, and of his harm the rote,
Anon he yaf the seke man his bote.
Ful redy hadde he his apothecaries,
To sende him drogges and his letuaries,
For ech of hem made other for to winne;
Hir frendschipe nas nat newe to biginne.
Wel knew he th'olde Esculapius,
And Deiscorides, and eek Rufus,
Old Ypocras, Haly, and Galien;
Serapion, Razis, and Avicen;
Averrois, Damascien, and Constantyn;
Bernard, and Gatesden, Gilbertyn.
Of his diete mesurable was he,
For it was of no superfluitee,
But of great norissing and digestible.
His studie but litel on the bible.
In sanguin and in pers he clad was al,
Lyned with taffata and with sendal;

And yet he was but esy of dispence;
He kepte that he wan in pestilence.
For gold in phisik is a cordial,
Therfore he lovede gold in special."
(from the Prologue to the TALES OF CAUNTERBURY)

THUS Chaucer describes the doctor as he knew him in or about the year 1386. He himself had now reached prosperous middle age. Except for a short interval under the regency of the Duke of Gloucester he had enjoyed for many years favour at the court of the young King Richard the Second, together with a pension, and various offices and their emoluments. He had travelled in the diplomatic service in Italy, France, and Flanders, and he sat (in 1386) in the Parliament at Westminster as a Knight of the Shire of Kent. In fact he knew the court and the world, and he knew the medical profession.

It is evident that there have been considerable changes since the days of the *archiatri.* Chaucer's physician is a man of standing, respected not less for his love of gold than for his scanty bible-reading, and a very different figure, in his scarlet and sky-blue silks, from the sombre brethren who staffed the spitals, and mingled pious exhortations with their potions. Above all he was a man of learning. Greek, Latin, and Arabic text-books were all within his compass—though it may be assumed that he read the Greek and Arabic in Latin translations—and he was well up-to-date with the latest English authorities, John of Gaddesden and Gilbert the Englishman, whose works were also, of course, in Latin.

His culture was primarily European, and European culture, especially in the field of medicine, was deeply in debt to the savants of the Moslem Empire, as Chaucer's list of medical writers shows. But European though he was in outlook and education, he must also have inherited a great body of traditional British folk medicine of which the origin was German and pre-Christian.

Tacitus relates that the German wounded were not attended by leeches, but were carried to their womenfolk for attention. It is a temptation to assume from this fact that some measure of rational medicine was practised, for a good cook must be in the habit of making observations of cause and effect. They made salves, potions and ointments mainly from herbs, some of which may have been genuinely medicinal, but it would be rash to assume that no nauseating ingredients, surviving from primitive medicine, were included.

Mackinney (in *Early Mediæval Medicine*) suggests that there was an unbroken tradition of medical prescriptions up to the Middle Ages, and that these prescriptions were a combination of folk-medicine, such as that of the German tribes, and classical remedies, handed down from Greece and Rome. Allied to these remedies there was a large element of magic in the shape of incantation and charm.

With the spread and organisation of Christianity the practice of medicine passed from the laity to the clergy. Charms and incantations remained, their importance increased rather than diminished, but their character was changed. "The monks referred sick people to God's will, prayer, holy water, and the relics of the saints", writes Meyer in *Geschichte der Botanik*—magic, in fact in a new guise, fortified by concoctions from the spital herb gardens.

It was this medical tradition, part classical, part herbal, part Christian-magical, that filtered into Britain with Christianity, and grafted itself on to the native practice.

It was not entirely unlearned. In the latter part of the seventh century the Pope had sent into England Theodore, a Greek of Tarsus, with assistants and a supply of books, to organise Greek and Latin scholarship on a Christian basis. Theodore founded a school in the year 669, and at this school John of Beverley, Bishop of Hexham and afterwards Bishop of York, the first doctor-priest in England of whom we have a contemporary account, was a pupil.

For this account we are indebted to the labours of the

Venerable Bede (673-735), who was concerned with ecclesiastical rather than with medical history, and therefore ascribes the cures effected by the Bishop to miracle. But Bishop Beverley was a man of learning, in the Greek tradition, and much of his reputation for miracle was probably founded on his knowledge and wisdom. The cure of the dumb boy with a bald and scabby head is a case in point.

It is evident from Bede's story that the boy was not a deaf mute, but suffered from a functional aphasia. The Bishop treated him by making him say the separate sounds represented by the letters of the alphabet. Then he went on to syllables and whole words, and eventually to sentences, until the boy was talking normally. Meanwhile the leech treated his head, an unpleasant business, beneath the dignity of a Bishop, and the boy was eventually sent away talking fluently, and with a fine head of curly hair. The hair is the clue to the time factor, for it is not suggested that the leech was capable of miracles, and although the cure is recounted as sudden and spectacular it is easier to believe that, whilst the scabs were being cleared up and the hair was growing, the saintly Bishop, with his magnetic personality, was coaxing the boy to speak. It is a miracle performed frequently by psychiatrists today, and its performance demands patience, intelligence and sympathetic understanding, qualities more creditable to the Bishop than a facile gift for magic.

But intelligent though he undoubtedly was, and learned in the learning of his time, the Bishop was not free from the superstitions of his age, and it is not altogether professional jealousy that prompts him to say, when called in consultation, "You have acted very unwisely and unskilfully in bleeding on the fourth day of the moon; for I remember that Archbishop Theodore, of blessed memory, said that bleeding at that time was very dangerous, when both the light of the moon and the tide of the ocean are on their increase."

The theory behind the Archbishop's warning was that, as moon and tide waxed, the flow of blood would increase and become excessive. Belief in the ebb and flow of life with the moon and tides is as old as sympathetic magic, and even today we hear from time to time an echo of Mistress Quickly's "a parted even just between twelve and one, even at the turning of the tide."

Another medical reference in Bede's ecclesiastical history gives us the name of a lay physician, Cyngfrid, physician to Aedilthrid, daughter of the King of the East Angles. He lanced a tumour under the jaw of his noble patient, notwithstanding which she died. Laymen could not be expected to accomplish miracles, and probably the tumour was a sign of bubonic plague and likely in any case to be fatal.

Bede's history was written early in the eighth century. The earliest surviving English work concerned exclusively with medical subjects was written two centuries later. This is the 'Leech Book of Bald' which has been made available to us in a collection of Anglo-Saxon medical books edited in 1864-1866 by the Rev. Oswald Cockayne, M.A. and published under the title of *Leechdoms, Wortcunning and Starcraft of Early England*. Bald's book was not the first of its kind. It was transcribed for the use of a leech named Bald by one Cild, who copied most of it from older books unfortunately lost to us—probably burnt by the marauding Danes, who were as destructive to the considerable learning of Yorkshire and Northumbria as the Goths and Vandals to that of Rome.

'The Book of Bald' is a genuine handbook of a practising physician. Other physicians are quoted as authorities. "Oxa taught this leechdom" prefaces a remedy for 'Theor disease', which foreshadows the music Shakespeare was to make out of the names of English herbs and flowers:

> "Take wallwort, and cloffing and kneeholn and everlasting, and cammock and tunsingwort, nine parts, brown (wort), bishopwort, and attorlothe, and red nattle and red hove, and wormwood and yarrow and horehound, pellitory, and pennyroyal; put all these worts

> into Welsh or foreign ale and let him then drink it nine days, and be let blood."

It would take a good botanist to grow and compound this simple, which, by the way, is the name given to infusions of herbs, or of herbs dried and reduced to powder. Simples are the main prop of tenth-century prescriptions. They call to mind the 'bouillons' still popular in France, which are more appetising, if little more efficacious.

To those with small Latin and less Greek, symptoms described in the 'Book of Bald' are more recognisable than some of their modern equivalents, for example, 'half-head's ache' for migraine, 'black and deadened body' for gangrene, 'half-dead disease' for hemi-plegia, 'mickle-body' for elephantiasis; whilst 'flying venom' gives a vivid idea of air-borne contagion.

Worms are more difficult to classify, for in Anglo-Saxon (as to a lesser extent in modern German) a worm might mean anything from a dragon to a nit; and worms, snakes, and dragons —to increase the confusion—represent the forces of evil. The conception of the victory of Saint George over the dragon is that it was gained by means of a sword, but there is a picture in a Harleian Manuscript (No. 5294) of the deed being performed by means of potions prepared by leeches and apothecaries.

The remedy for 'hand-worm', however, suggests neither dragon nor evil genius, but *acarus scabiei*, which, in the prevailing conditions of dirt, must have been a common affliction.

> "Against a hand worm take ship-tar and sulphur, and white salt, mingle them together and smear therewith."

A 'deaw worm' requires more drastic treatment. Perhaps this 'worm' was that tiresome fungus disease commonly known as 'athlete's foot'.

> "Against a deaw worm let a man step upon a hot coal; let him cool (his foot) with water, let him step upon it as hot as he hottest may."

These examples of Bald's medicine give some idea of the native tradition in Britain a hundred years or so before the Norman Conquest. With the Normans came a fresh impetus from Europe, bringing with it this time a considerable contribution from the Arabs, and some tattered remnants of Greek learning. These were blended incongruously with what Anglo-Saxon tradition survived the invasion, and, as Chaucer's medley of names implies, formed the professional heritage of the mediæval physician.

The Greek tradition of medicine had never completely died out in Europe. It had lingered on in Sicily and southern Italy, until, in the ninth century, reinforced by the developments in Arabian medicine, it had blossomed again at Salerno, and thereafter at Montpellier, the great medical school that still flourished in Chaucer's time.

The link between Greek medicine as preserved in the Roman Empire, and Arabian medicine as it developed in the Moslem Empire, which, at the height of its glory, stretched from Spain to Samarkand, was provided by the Nestorians. They were the followers of Nestor, a Patriarch of Jerusalem, who in A.D. 431, in the course of the polemical battles of the early Church, was banished for heresy. He founded a medical school at Edessa, and, when persecution still pursued him, took refuge in Persia, where, in Ctesiphon, Chosroes had founded a university. The Nestorians laboured industriously at the work of translating Greek texts into Syriac and Arabic, and so preserved them when Greek itself was half-forgotten, and made them available to Arab physicians, who studied them with care, and added in the margins voluminous comments and accounts of experiences of their own.

When, centuries later, the European medical schools began to flourish, these same texts in Syriac and Arabic, corrupt as they had become, were done into Latin, text and commentaries inextricably confused, and became the textbooks in general use—'Deiscorides, old Ypocras and Galen'—which the Doctour of Phisyk 'wel knew'. One of the most able of these later translators was 'Constantyn' the African, who was born at Carthage, became in the eleventh century one of the most able Chancellors of Salerno, and finally retired into the monastery of Cassino to pursue undisturbed his work of translation.

In the meantime the Arabs had made a distinguished contribution to medical discoveries, and to the medical texts available and in use in Chaucer's time. Razis (850-932)—we spell it Rhazes nowadays, but his full name was actually Abu Bakr Muhammed ibn Zakariyya—was a Persian who wrote a treatise on smallpox and measles, and was the first to differentiate the two diseases. Avicen—or Avicenna—(980-1037), also a Persian, was the author of a Canon of Medicine in use at Montpellier until 1650. He was the first to describe tuberculosis and to classify it as an infectious disease. Averrois—or Averroes—(1126-1198), lived at Cordova, and was the first to put on record the long incubation period of rabies, a very important factor in its prevention and cure, as Pasteur was to discover nearly eight hundred years later. These are only a few of the great names in Arabian medical history. They were as familiar to Chaucer as they were to his Doctour of Phisyk, who, it seems probable, though Chaucer does not mention it, had studied at Montpellier.

That the learned Doctour was 'grounded in astronomye' and well-versed in the four humours need not surprise us. The science of astronomy, which became debased to the quasi-magic of astrology, was Oriental in origin, and the four humours can be traced back to Aristotle. In mediæval physiology the 'hoot or cold or moiste or drye' corresponded to blood, phlegm, choler or yellow bile, and melancholy or black bile; and health depended on a proper balance of the four. These 'humours' still survive in the description of temperaments as 'sanguine', 'phlegmatic', 'choleric', or 'melancholic'.

Gilbert the Englishman, Gilbertus Anglicus, or simple Gilbertyn, author of a *Compendium Medicinæ, the Lily or Laurel of Medicine*, was in his grave before Chaucer was born, but John of Gaddesden was not only alive, but had been court physician at the same time as Chaucer had been a page in the household of Elizabeth, wife of Lionel, Duke of Clarence. It is impossible that they did not meet, almost impossible that the observant youth did not remember many of his characteristics when he came to depict his Doctour of Phisyk some twenty years later.

For John of Gaddesden was a personality not readily forgotten, and he did not hide his light under a bushel. It is not necessary to draw on the imagination for a picture of him, for in his book *Rosa Medicinæ*, whilst writing ostensibly of diseases, patients, cures, and treatment, he draws his own portrait for us, line by line, as Chaucer drew it for the entertainment of the court that had once known him, and who probably enjoyed it all the more for calling him to mind.

Early in the eighteenth century Doctor John Freind, drawing largely on the *Rosa Medicinæ*, wrote his biography in *The History of Physick from the Time of Galen to the Beginning of the Sixteenth Century*. A few facts from this work will help to round off the portrait.

He was born about 1280 on the edge of Ashdown Forest near the church of Little Gaddesden, and, as was then customary, took the name of the parish in which he was born. He studied at Merton College, Oxford, some thirty miles away as the crow flies, and it is recorded that whilst he was there he cured a 'Scholar and a Noble Bachelor.' As the study of medicine at Oxford involved no practical experience, the cure must have been effected by treatment culled from the works of the masters; it may be that old mother nature obligingly co-operated.

The next step to be taken by an ambitious young physician was to study at one of the great medical schools of Europe, and it is probable that John made his laborious way to Montpellier and took a medical degree there. Doctor Freind is of the opinion that on his way home he visited the medical schools of Paris, a likely supposition and in accordance with the habit of scholars to foregather, a habit not limited by any language barrier, Latin being their common tongue. Be that as it may, on his return to England he set up in practice in London with the intention of becoming a fashionable physician. Indeed any successful physician of his day must have been fashionable, for the poor received little or no medical attention, even in the spitals, and probably died the more peacefully on that account.

In the small world of London John's reputation spread rapidly amongst the nobility and gentry (there was no ban on advertising in his day, and had there been one he would probably have circumvented it), he was introduced at court, and became one of the first English court physicians.

Modesty was not a virtue highly thought of in the fourteenth century, indeed probably not until Arnold popularised it in the public schools. John of Gaddesden certainly suffered from no such inconvenient restraint, and in his work *Rosa Medicinæ* he explains confidently that as the rose excels all flowers (including of course the 'Lily'), so his book excels all treatises on the practice of medicine. It is true that he gathered with his rose, as in a pot-pourri, the essence of many other flowers, including the aforementioned lily, for the book is full of Latin tags and texts, of quotations, acknowledged and unacknowledged, from Greek and Arabic authors, and, of course, from his near-contemporary Gilbert.

He describes fevers and injuries, much as Galen had done; he gives prescriptions, cooking recipes, instructions for making perfumes, washes, hair dyes, and a 'spicnard'—as a cure for palsy—so precious that it "ought not to be given without receiving a salary first for it."

He recounts how he cured colic with a girdle of sealskin buckled with whalebone, palsy in the tongue with an *aqua vitæ*, epileptic fits with a necklace. His description of his cure of the smallpox is quoted in many medical histories, a fact that would have given him immense satisfaction. The patient was no less a person than a son of Edward the First, and was in a position to be cured in the most expensive style. He was wrapped in scarlet cloth, placed in a bed hung with scarlet curtains, and kept in a room decked with scarlet hangings. And, declares John in triumph, '*est bona cura, et curavi in sequenti sine vestigio variolorum*'—"it is a good cure, and I cured him, as a result of it, without a trace of pock-marks." Whether the cure harked back to the cure of like with like, or forward to cure by (infra-red?) radiation, is a point that has been debated, but that it was a cure is beyond dispute.

Gentleman-physician and learned doctor though he was, John was not above turning an honest penny—provided it was a silver one—by practising the minor arts of his profession. He went in for bone-setting, and, in spite of the fact that he was in priest's orders, he performed surgical operations, such as they were. He merchanted 'strong water and brandy' and made a great profit by it; he drew teeth, made war on lice, treated corns. He even dabbled in poetry.

Doctor Freind writes of him, "He was sagacious enough to see through the foibles of human nature, how far mankind could be imposed upon. . . . He is very artful in laying baits for the Delicate, for the Ladies, for the Rich. For the former he has such a tenderness that he condescends to instruct them in Perfumes and Washes, especially some to dye their hair, and such a respect for the latter that he is always studying to invent some of the most select and dearest of medicines."

He gave his patients, in short, what they asked for, and what doctor who has sent a neurotic patient away with an unnecessary bottle of medicine will condemn him out of hand? Effectual medicine was at the time practically non-existent, and sick folk require fuss and attention, especially when they are rich. His was a well-to-do practice, but there is no record that he sent the poor away empty-handed—if they succeeded in approaching him.

There is evidence that in the year 1342 he occupied the stall of Wildland in the Cathedral of St. Paul's. It is difficult to believe that when he knelt before his Maker his sense of sin was unduly oppressive, and it is tolerably certain that he was satisfied that his riches were as well-deserved as well-earned. It was not an age of introspection, and when he died at a good old age in 1361 it could be said of him that he had served his patients according to his lights, which at that period were rather dim.

If this mediæval physician has interested us sufficiently—and he is a gay and attractive figure—for us to wish to learn more of his contemporaries, there are other authorities. There are, for example, the instructions on procedure contained in *De Adventu Medici Ægrotum* written in the twelfth century by Archimathaeus, a master in the medical school of Salerno; and there are pictures of the doctor at work, executed with exquisite skill in the manuscripts of his time. One of these (Bodleian MS. Ashmole 399), painted in the thirteenth century, shows the physician on his rounds, riding a lively little stallion, and followed, for he is a man of consequence, by his servant, on foot. He may or may not follow the instructions of Archimathaeus:

> "When called to a patient commend yourself to God, and to the angel who guided Tobias."

It is not likely that the Doctour of Phisyk took this piece of advice too much to heart, but the next section concerned him closely, for he must "the cause y-knowe, and of his harm the rote" before he "yaf the seke man his bote."

> "On the way learn as much as possible from the messenger, so that if you discover nothing from the patient's pulse or water you may still astonish him and gain his confidence by your knowledge of the case. On arrival ask the friends whether the patient has confessed, for if you bid him do

> so after the examination it will frighten him. Then sit down, take a drink, and praise the beauty of the country and the house, if they deserve it, or extol the liberality of the family."

The modern General Practitioner will envy his mediæval colleague this leisurely approach, which would still have its advantages as a preliminary to diagnosis.

At last the patient himself has his turn; we see him depicted in a French manuscript of the thirteenth century (*Bibliothèque Nationale* Paris MS. lat 8846) lying in bed stark naked, as the custom was, his short-cropped head propped upon what looks like a very hard cylindrical bolster. Nakedness, however, was not in order if the patient was a woman. Even for the visit of her physician she must be fully clad in the ample costume of the period, including head-dress. Thus we see her in the Bodleian manuscript already referred to, well covered in bed-clothes, with three priests and a female relative in attendance, for there must be no breath of scandal, and the physician was not always above a little dalliance—unless the following admonition was superfluous:

> "Look not desirously on the man's wife, daughter, or handmaid, for this blinds the eye of the physician, deprives him of the divine assistance, and disturbs the patient's mind."

The patient's mind was all too liable to be disturbed, in any case, by other causes:

> "Next proceed to feel his pulse, remembering that it may be affected by your arrival, or, the patient being a miser, by thinking of the fee."

Fees apparently were high, and so was the price of drugs. Edward the First paid no less than £134 16s. for drugs alone, and no doubt the fee of his doctor, Nicolas Tingewick of Balliol, was proportionate.

After the pulse came the examination of the urine, a method of diagnosis that persisted into the seventeenth century, and still forms an essential part of a complete examination. It held so important a place in mediæval medicine that the flask used for the purpose was the physician's trade sign.

Pulse, urine, the gossip of the messenger, and what might be gathered indirectly whilst taking his apéritif must all be summed up, and the process must not be hurried.

> "Do not be in a hurry to give an opinion, for the friends will be more grateful for your judgment if they have to wait for it. Tell the patient you will cure him, with God's help, but inform his friends that the case is a most serious one."

But the physician did not earn his fee by a mere diagnosis. Treatment of some kind must certainly be given. The Doctour of Phisyk was no great believer in waiting upon nature. Bleeding was a popular remedy, but only if the day was propitious. Some simple or electuary must also be prescribed, or the physician would lose favour with the apothecaries, "for ech of hem made other for to winne." The electuary was the very latest thing, a compound of powders of various kinds with honey or syrup, devised by the Arabs, and much in favour of Salerno. If the patient was very rich and important he might be dosed with Theriac, which was a universal remedy said to have been invented by Mithradates, King of Pontus, and very expensive to make, for it contained many rare ingredients. One Pharmacopœia, the Dispensatory of Cordus, enumerates no less than sixty-four.

The medicine might be compounded by the physician and his assistants on his return home, or it might be supplied by an apothecary. There was not then the exact distinction familiar to us nowadays between physician and apothecary, for the physician compounded drugs, and the apothecary treated patients (a sin he still commits on occasion, albeit gratis). This secondary function of the apothecary survives in a medical diploma, Licenciate in Medicine and Surgery to the Society of Apothecaries, which is recognised as an honourable and adequate qualification for practice.

In addition to the potion there were directions to be given to the attendants as to diet and general treatment. A prayer or charm might also be required. When all this had been seen to, dinner in the household followed:

> "If, according to custom, you are asked to dinner, do not hasten to take the first place, unless, as is usual for the priest and the physician, it is offered to you. Often send to enquire how the patient is, that he may see you do not neglect him for the pleasures of the table, and on leaving express your thanks for the attention shown you, for this will please him much."

And so, with much dignity and some self-importance, he mounts his little stallion and makes his way home, his thoughts divided between doubts as to whether the trouble was due to yellow or black bile, and the problem of the fee he might reasonably demand if the patient recovered.

At home there are more patients to be attended to, and he sits in his laboratory in his great chair, in his sky-blue and scarlet robes, trimmed with fur and lined with satin. Around him on the shelves are flasks and jars, pestles and mortars, retorts and crucibles. Herbs hang drying from the ceiling, cauldrons simmer on the fire, attendants come and go, drugs are pounded, salves and ointments are prepared.

But the patient tells his story, and the physician listens. He or his assistant may bleed, or cup, or bandage, or the patient may go away with simple or electuary. But at least he gets advice from one who does his best to cure him, though the means at his disposal are mostly ineffectual. Cures there undoubtedly were. The *vis medicatrix naturae*, and he probably knew it, was the physician's most powerful ally. He was a man of his time, and in his time received respect and honour and a good income. In one way or another he no doubt earned all three.

CHAPTER SIX

Anatomy and Physiology

> "*Non fingendum, aut excogitandum, sed inveniendum quid natura faciat aut ferat.*" *It is meet not to imagine or think out, but to find out what nature does or produces.*
>
> (THE LORD CHANCELLOR BACON)

JOHN of Gaddesden died in 1361, and Chaucer in 1400, but Doctours of Phisyk continued to carry on their profession with little alteration in method or outlook for some two hundred years or more. They were ignorant not only of the functions, but even of the structure of the body, and most of them were content to remain so until the Renaissance rekindled a light that had burned but dimly since the days of Greece, and awakened a new curiosity that was no longer content with mere appearances.

If it is possible to give a date to an intellectual revival that changed and is still changing the face of the world, the year 1543, in which Constantinople was sacked by the Turks, is a convenient one. The result of this attack on what stood at the time for civilisation was the dispersal of Greek scholars and of the remnants of Greek libraries throughout Europe, where their impact on minds fresh and vigorous, but hitherto unlearned, resulted in an urge to a further search for knowledge that has not yet spent itself. It was like the ploughing up and sowing of a field that had lain fallow, and the growth that followed surpassed that of the exhausted soil previously cultivated.

Another event that gave impetus to the spread of culture was the invention of printing, which happened about the same time (so far as Europe was concerned.) The scholar was no longer dependent on travel and conversation and the laborious scratching of monastic pens for communication with his fellows. His works could be multiplied and circulated, his hard-won knowledge could be assimilated by others, and so expanded and increased. A hardy annual had given place to a tree.

The first important development in medicine was in the field of anatomy. It is strange that, during the long ages in which human life was of so little account, the human body, even hanged, drawn, and quartered, should have been so regarded that even its bony structure remained a mystery. The Egyptians, in the process of embalming, must have learnt something of the internal organs, but the body was treasured up in the conviction that the soul would have further need of it. The Hippocratic school knew nothing of dissection; Galen dissected the ape in the belief that, except in the want of a soul, it was identical with man. The Koran expressly forbade human dissection, and Christian dogma was equally opposed to it.

In these circumstances it is surprising that anything at all was known of anatomy. But occasional exceptions had been made to the ban. The Emperor Frederick the Second, whose intelligent interest in medical education has already been noticed, issued in 1213 a licence to the medical schools of Sicily and Naples to dissect one body every five years. Public opinion, however, was against the practice, and little advantage seems to have been taken of the permission.

About a hundred years later, in the year 1306, Mundinus, the Professor of Medicine at Bologna, caused something of a scandal by dissecting the body of a woman, and when the scandal had had some ten years in which to die down he dissected two more bodies. The book in which he described these dissections was amongst the earliest publications of the printing press set up at Pavia, and, incomplete and faulty though it was, it contained the most accurate information available to the student of the time. Interest in the subject was slowly growing in the medical schools, and more rapidly in the art schools.

For artists were no longer satisfied with draperies and flat abstractions, however gorgeous and full of character. They began to draw the nude body, and to give it roundness, depth, and, above all, movement. Surface appearance was not enough. They must know what lay beneath the surface, bone, muscle, and sinew, they must understand the strains and stresses at work in action. It is said that Leonardo da Vinci filled many notebooks with anatomical drawings, and that with his friend Marcantonio della Torre he dissected numerous bodies. Unfortunately most of these notebooks have been lost, but it is difficult to believe that some of the forms he drew could have been executed without a detailed knowledge of the body's structure, though some are said to bear traces of Galen's Barbary ape. Leonardo may have dissected both, for it is known that about this time—he lived from 1452 to 1520—licences began to be more generally granted for human dissection.

In the Universities these dissections were not performed by the "Master", but by a surgeon or menial, whilst the Professor sat on a platform above in his great chair and read aloud the works of Galen. In this practice the title of "Reader" originated and also the custom of appointing professors to purely mythical chairs.

Anatomy lectures of this kind soon began to cause difficulties, for whilst the Master read anatomy as it was understood by Galen in the chair above, the demonstrator showed the structure of the body in the corpse he was dissecting below. It became evident, and the evidence was there in full view of the beholders, that there was some discrepancy between the two. Some of the statements of Galen did not accord with the facts. Had the human frame changed in the intervening centuries? Or—awful heresy—was Galen wrong?

In the year 1543 Vesalius published his great work *De Humani Corporis Fabrica.* It answered these questions in unequivocal terms, and put the study of anatomy once and for all on a scientific basis. But when the awkward questions first occurred to Vesalius he had to find the answers for himself, and in the new spirit of the age he realised that there was only one way, to investigate and discover.

Andreas Vesalius was a man of the Low Countries, and was born in 1514 at the town of Wesel, in Cleves, from which he took his name in lieu of the family name of Wittings. He came of a family of distinguished doctors, and far from being frustrated by the experience already gained by his parents, as is so often the case in these tender days of complexes, he had no thought but to profit by it, and to build upon the foundation already laid. He was sent at an early age to study medicine at Louvain, and when he was still only eighteen he went on to the medical school of Paris, where he turned a critical eye on the anatomy teaching of Silvius—or, in his native tongue, Jacques du Bois. Andreas had already learnt much from the dissection of animals, for, like Hunter in later years, he dissected whenever he could. There are stories, too, and there is every reason to believe them, of his digging up limbs from the cemeteries, and even stealing a corpse from where it hung rotting and useless on the gallows, and keeping it hidden, to study in secret. Now and again there was a body to dissect at the schools, an opportunity that he was the more ready to seize upon as a result of his growing aptitude and experience.

After returning to the Low Countries for further study he found his way eventually to the University of Padua, meeting on his way there Johann Stephan von Kalkar, a fellow countryman who had been studying painting in Venice under Titian.

At the age of twenty-three he took his Doctor's degree, and without further delay he was appointed professor of surgery and anatomy, on which he was probably already the greatest living authority. A few months later he published an atlas of anatomy, containing illustrations by his friend Kalkar, three of which were drawn from his own dissections. It was the forerunner of his great work.

For six years he lectured and demonstrated at the Universities of Padua, Pisa, and Bologna. Meanwhile he was entrusted by a firm of Venetian printers with the translation and editing of the anatomical section of a projected Latin edition of the works of Galen, in which it was proposed to include his commentaries. But Galen's anatomy had ceased to satisfy him. Taking advantage of the opportunities for dissection his appointment afforded him, he checked and checked again the differences between his own findings and the teaching of Galen. As he worked he made notes and diagrams. The discrepancies grew beyond the compass of commentaries. He realised that emendations would never be sufficient. What was required was a complete new anatomy, not the Anatomy of Galen, nor even the Anatomy of Vesalius, but the anatomy of the human body as it could be seen and demonstrated, and—for the subject is extremely complicated—corrected and extended.

With the disciplined energy that only genius can command he set to work. Kalkar, with equal enthusiasm, collaborated. In a few short years of single-minded labour almost incredible in this distracted age the work was ready for the press. Travelling with mules he took manuscript and plates across the Alps to Bâle, where in June, 1543, it was published—663 folio pages, with over 300 illustrations—under the title *De Humani Corporis Fabrica*, or the Fabric of the Human Body. It was dedicated to the Emperor Charles the Fifth, and in the dedication Vesalius tells his patron that he had scarcely completed his twenty-eighth year.

The importance of the work can hardly be exaggerated. It was the first complete textbook of anatomy; it was exquisitely illustrated; it was lucid, and, with the exception of minor mistakes, inevitable in such a comprehensive work, it was correct. It was the foundation and pattern of modern descriptive anatomy, and no manual or atlas of anatomy has since been written that is not indebted to it.

Its publication roused the expected storm. Vesalius could have been forgiven for proving Galen wrong, but what his contemporaries could not forgive was that they, who "from the elevation of their chairs repeated emphatically, like parrots, what they found in books, without even having made for themselves the least observations," were made to look foolish. He sheltered from the storm under the patronage of the Emperor Charles the Fifth, to whom he became court physician, and on the death of Charles he went to Spain in the service of Philip the Second. What his subsequent activities were we do not know. He is reported to have returned, on one occasion at least, to lecture at Padua, where students and masters thronged to hear him. Kalkar's frontispiece to the first edition of the *Fabrica* gives us a picture of a lecture in progress. Doctors and students crowd around, servants wrangle under the table, a bystander proffers a razor, whilst Vesalius himself, a neat little man, immaculately dressed and with well-trimmed hair and beard, displays with his elegant hands the abdominal cavity he has just opened. A monkey creates a diversion in one corner, in the gallery above the general public argue and jostle, whilst in the midst of the hubbub two students are absorbed in a book on the cover of which is a large G. But Galen, genius though he was, has had his day, and a human skeleton shares the centre of the picture with the corpse. From these, and not from ancient books, knowledge is to be obtained of what nature is and does.

It was said by some that the University of Padua invited Vesalius to return to his chair, but the reports are conflicting. There is a completeness about his work that seems to demand no extension of service. All that we know is that from Spain he went, as fashion and religion recommended, on a pilgrimage to Jerusalem, and on the return voyage was wrecked on the island of Zanthe in the Ionian Sea, where he died in the autumn of the year 1564 at the age of fifty, and was buried in a small chapel on the island, dedicated to the Virgin Mary. His effectual future lay in England, with William Harvey, who was born fourteen years later in the seaside town of Folkestone. Fourteen years and the continent of Europe separated them in time and space, but their work was continuous, as in a relay race the baton is carried on, handed from one runner to the next.

There was also a personal link, the relationship between pupil and teacher, that was continuous.

When Vesalius relinquished the chair of anatomy and surgery at Padua he was succeeded by his pupil, Columbus, who made some progress in work on the function of the heart. In 1551 Columbus was succeeded in his turn by his pupil Fallopius, and when Fallopius died in 1565—the year after the death of Vesalius—he was succeeded by his twenty-seven-year-old pupil, Fabricius of Aquapendente, who occupied the professorial chair until his death in 1619. In 1598, when Fabricius had reached the age of sixty, William Harvey, a young student from England, arrived at Padua for his four years' medical course.

The early influences on Harvey's life had been neither medical nor scientific. His father Thomas was of yeoman stock, and was an alderman, and later mayor, of Folkestone; all that is known of his mother is that her name was Joan Halk, that she was Thomas Harvey's second wife, and that she had by him seven sons and two daughters, of whom all the sons lived to maturity and had successful careers, whilst of the daughters one died at the age of eleven, and the other married, had children, and lived on into middle age; evidently a sturdy family both physically and mentally.

Thomas Harvey must have had a discerning eye for talent amongst his children; he apprenticed four of them to trade, whilst a fifth was found a post at the court of King James. William, the eldest, was destined for one of the learned professions. In 1588, the year of the defeat of the Spanish Armada, he was sent to the Grammar School at Canterbury; at sixteen he entered Caius College, Cambridge, and in 1597 graduated as Bachelor of Arts. The subjects for this degree were Latin, logic, and divinity, but Harvey had also enjoyed opportunities for practical studies, for forty years earlier the College, refounded as Gonville and Caius by Doctor Caius, had received a Charter from Queen Elizabeth which allowed the annual dissection of the bodies of two executed criminals. It must be remembered that an allowance of two bodies was not sufficient for exhaustive dissection, for, owing to lack of preservatives, the operation could occupy only about a week, and must be performed in cold weather. But those two annual dissections were sufficient to arouse the young man's interest in anatomy, and may have been influential in directing his steps to Padua, where Doctor Caius had studied under Vesalius, and which was for more than a hundred years the most brilliant school of anatomy in the world.

There was still no effective medical school in England, and it was a matter of course for a physician who hoped to stand high in his profession to go to France or Italy for his medical degree. Thomas Harvey evidently had ambitions for his son and did not intend him to become a mere surgeon or apothecary, certainly not a country quack, so, in spite of the dangers of travel and the expenses that must be incurred, he packed him off at the age of twenty to the University of his choice.

Fabricius of Aquapendente was a great teacher, a distinguished surgeon, and probably the greatest living anatomist. In spite of the magnitude of the work of Vesalius, or probably because of it, he realised that much, particularly in the realm of function, had yet to be discovered. His own special line of investigation had been on the valves of the veins, which, he noticed, allowed the blood to flow in one direction only, namely towards the heart. In 1574 he had published a work, *De Venarum Ostiolis*, on the Little Doors of the Veins; but he had arrived at no satisfactory conclusion about the function of the little doors, and no doubt the subject continued to exercise his mind. In the young English student he recognised a mind not only receptive, but also original. The problem was no doubt discussed between them. Fabricius did not live to find the solution, but he had passed it on to one who was not to lay it aside until he had discovered it.

It was not only on Fabricius that Harvey made an impression at Padua. The University was at that time a student university, that is to say it was governed by the students themselves in a Concilarius. Of this governing body Harvey became a member, as a representative of the English 'Nation' or body of students, and his 'Stemma'—it seems that his family did not then possess a coat of arms—has been discovered over the capital of one of the columns in the cloister of the University. It represents a hand holding a lighted candle with a snake on either side, above it, 'Anglica', and below, 'Gulielmus Harveus Anglus'.

On April 25th, 1602, at the age of twenty-four, Gulielmus Harveus received the diploma that conferred on him the degree of Doctor of Physic, and gave him leave to practice and teach arts and medicine in every land and in every seat of learning. It followed a viva-voce examination by the Masters, and was expressed in terms of the highest appreciation, but how much of this was genuine tribute and how much the fulsome flattery of the period it is hard to say. At any rate he was well received on his return to England, and the University of Cambridge conferred on him the degree of Medicinae Doctor without further examination. In spite of his distinguished degrees, however, he was not yet equipped for practice in London.

In 1509 a very necessary Act had been passed limiting the practice of medicine in the towns to those examined and licensed. Licences were issued by various bodies, including the Archbishop of Canterbury, a privilege he retained until 1838, but the most important licensing body for London was the College of Physicians, which had received its Charter from Henry the Eighth in 1518. In the year 1604, then, William Harvey, Doctor of Physic of Padua, Medicinae Doctor Cantab., received his L.R.C.P., and his equipment for the profession of fashionable London physician was complete.

The glory of the Elizabethan age was over. James, the First of England and Fifth of Scotland, sat unromantically on the throne, whilst his Queen tripped through the measures devised for her by Ben Jonson and decorated by Inigo Jones. The new century was to be shadowed by wars and revolutions and countless senseless executions, but Harvey's little candle was already alight, and before fifty years had passed it had thrown its beams so far that the Invisible College was already in being, and met to discuss neither politics nor religion, but the astonishing works of nature.

Harvey settled down in London and married the daughter of Doctor Lancelot Brown, physician to James the First, and previously physician to Queen Elizabeth, after whom he had named his daughter.

The wives of great men seldom step into the limelight, but we have a pleasant firelight picture of her in Harvey's own words. He describes her with her pet parrot that "called for its mistress when she was abroad, greeted her cheerfully when it found her, answered her call, flew to her, and aiding himself with beak and claws, climbed up her dress to her shoulder, whence it walked down her arm and often settled upon her hand . . . . Playful and impudent it would often seat itself in my wife's lap to have its head scratched and its back stroked, whilst a gentle movement of its wings and a soft murmur witnessed to the pleasure of its soul." The passage leads on to the vexed question of sex in birds, but it is a tender description and could not have been written but by one who took delight in the picture.

As far as can be ascertained, they had some forty years of married life together. We may imagine her conducting his household with the grace and gentleness that endeared her to the parrot, and dying some time during the dark years when he lost so many friends, including his Royal master. They had no children.

But these events cast, as yet, no shadows. Three years after his marriage he became a Fellow of the College of Physicians, and in the same year was appointed assistant to Mr. Dr. Wilkinson in his work of Physician to St. Bartholomew's Hospital, whom he succeeded on his death in 1609.

The appointment entailed attendance at the hospital once a week, or oftener if necessary, not indeed to visit the patients in their beds (that was the office of the surgeons), but to sit in the great hall, where such of the inmates as required medical attention, evidently not all of them, were brought to him by the hospital officials, to take, in turn, their place beside him on the wooden settle, whilst matron and sisters attended to receive his instructions. He wrote his prescriptions in a locked book, for which only he and the apothecary had the key. Grave warnings were issued against collusion for their mutual profit, for the time had gone when each could "make other for to winne." When necessary he had to treat the patients at his own home. The salary was £25 per annum, so the chief gain must have been experience and prestige. It was increased later by £8. 6s. 8d. on the grounds that Harvey was not accommodated with a house, so we may take it that this sum represented an adequate rental.

Some twenty years after his appointment Harvey met the governors, apothecaries, and surgeons of the hospital to discuss reforms considered necessary to its efficient working. His recommendations included the appointment of two physicians instead of one; the regular discharge of patients when cured or incurable; punishment or dismissal for those who would not take their physic; and the complete subjection to the physician of the surgeons, who without his sanction were to give no physic, nor perform any serious operation. This recommendation could not have been welcome, but it was evident that some supervision was necessary, for surgeons had to be forbidden to allow their servants to operate. As to the physic, this must have been a very sore point indeed, for prescriptions were valuable assets secrets, not of the profession but of the individual, and whilst the physician kept his in a locked book the surgeon was expected to recite his for staff and patients alike to hear. Harvey was being unreasonable. Secret remedies were still by no means out of fashion, and the King himself used some that had not even the authority of a surgeon, as his evidence before the House of Commons showed, when enquiries were being made into the circumstances of the last illness of King James. Harvey deposed: "They said the plaster was a secret of a man of Essex. Hayes laid it on. The King liked it. . . . The King took divers things whether they would (or) not, undervaluing physicians", as physicians were to undervalue surgeons for some time to come.

So far we have only a picture of Harvey as a practising physician. Whether he was a good one we cannot judge. Aubrey says no, but his only authority was gossip, which is notoriously inaccurate where medicine is concerned. What we do know is that in 1618 he became Physician Extraordinary to King James, and in 1631 Physician in Ordinary, a more important post, to Charles the First, with a salary of £300 a year. In 1639 his salary was raised to £400 a year, with three dishes of meat each day at dinner, and lodgings at Whitehall, for he was now Senior Physician to the King, whose friendship and trust he retained until the end. Even Aubrey accepted his ministrations without demur when he had reached that eminence.

But Harvey's importance to the world was not as a physician—that was Sydenham's distinction—but as a physiologist. He was already the leading anatomist of his time, a fact recognised by the College of Physicians when, in 1615, they made him Lumleian Lecturer to the College. This lectureship had been founded in 1581 by Lord Lumley and Doctor Caldwell to improve the standard of education in surgery. The course was to be spread over six years. Twice a week, on Wednesdays and Fridays, an hour's lecture was to be given at the College, three-quarters of an hour in Latin, and the other quarter, perhaps lest misunderstandings should occur, in English. Every winter a body was to be dissected "for five days together, as well before as after dinner, if the bodies may last so long without annoy", the dissections being arranged so that the subject should be covered during the six years' course.

Harvey held this appointment and, except for some interruption during his travels and during the Civil War, conscientiously discharged the duties it involved until July, 1653, when, as an old man of seventy-eight, less than a year before his death, he begged to be allowed to retire.

His lecture notes, treasured in the British Museum, are amongst the most fascinating of medical documents, but they are not easy to decipher. His handwriting is difficult, though Aubrey declares that he could read it after some practice. Then he writes in a mixture of Latin and English, and includes signs and symbols, intelligible, no doubt to the lecturer, but to no one else. One often quoted extract, however, among the more generally intelligible, shows his preoccupation with function, and a picturesque mode of expression that must have been a great help to the students' memory:—

> "An Cerebrum, Master: Spina his mate
> Nervi, Boteswayne
> Musculi, Saylors."

His notes on the three types of dwarf compose something of a detective puzzle, with which those so inclined may entertain themselves. The passage runs:

> "UNDE NANORUM 3 species
> pigmei pusilli proportionate
> pomiliones sumbody informes ugly
> gibbosi QUIBUS SPINÆ CURVÆ ARTUS SATIS LONG
> gibber Gobbo Nang"

'Gobbo,' it should be explained, is the Italian for 'humpbacked' and might possibly refer to a statue of a humpbacked dwarf that he had seen in the market place at Venice.

The most significant fact revealed in these notes is that Harvey had already discovered the course of the circulation of the blood, and, quietly and unobtrusively, was teaching it to his students. The relevant passage runs:

> "It is plain from the structure of the heart that the blood is passed continuously through the lungs to the aorta as

> by the two clacks of a water bellows to raise water. It is shown by the application of a ligature that the passage of the blood is from the arteries into the veins. Whence it follows that the movement of the blood is constantly in a circle, and is brought about by the beat of the heart. It is a question therefore whether this is for the sake of nourishment or rather for the preservation of the blood and the limbs by the communication of heat, the blood cooled by warming the limbs being in turn warmed by the heart."

This was written thirteen years before the publication of his *Anatomical Essay on the Movement of the Heart and Blood in Animals*. What his friend Doctor Ent wrote of him to the College of Physicians in 1650 was certainly true: "And indeed so often as he has sent forth any of his discoveries to the world he has not comported himself like those who, when they publish, would have us believe that an oak has spoken, and that they had merited the rarest honours—a draught of hen's milk at the least. Our Harvey rather seems as though discovery were natural, a matter of ordinary business; though he may nevertheless have expended infinite labour and study on his works."

There is no doubt that during the years of lecturing and dissecting at the College of Physicians he did expend 'infinite labour and study', until the action of the heart and the circulation of the blood had been so clearly demonstrated and so irrefutably proved that further argument would be fruitless.

His essay, written in Latin and entitled *Exercitatio Anatomica De Motu Cordis et Sanguinis in Animalibus*, was published in 1628 at Frankfürt by William Fitzer. The choice of a German publisher may have been dictated by the wish to avoid trouble, or, in a European such as Harvey was, it may have been without significance. Argument there was, and a degree of contempt for these wild new theories, but it cannot be said that Harvey was victimised. He went on with his

Lumleian lectures, enjoyed court favour, and although it was said that his practice fell off considerably after the publication, it was not his only or, it might be ventured, his chief interest.

His discovery laid the foundation of rational medicine. That it would have been made sooner or later is true of most discoveries. For half a century the anatomists had been on the brink of it. Galen had made the distinction between veins and arteries; the lack of communication between the ventricles had been discovered by Vesalius; the pulmonary circulation by the unfortunate Servetus; and some have claimed that Columbus had actually envisaged the circulation. There is a passage in Robert Boyle's *Disquisition about the Final Causes of Things* that suggests that Harvey's greatest debt was to his own teacher, Fabricius of Aquapendente. It runs:

> ". . . I remember that when I asked our famous Harvey in the only discourse I had with him (which was but a while before he died), What were the things that induced him to think of a Circulation of the Blood? He answer'd me, that when he took notice that the Valves in the Veins of so many several Parts of the Body, were so plac'd that they gave free passage to the Blood Towards the Heart, but opposed the passage of the Venal Blood the Contrary way: He was invited to imagine, that so Provident a Cause as Nature had not plac'd so many Valves without Design: and no design seemed more probable, than That, since the Blood could not well, because of the interposing valves, be sent by the Veins to the Limbs; it should be Sent through the Arteries, and Return through the Veins, whose valves did not oppose its course that way."

Although Harvey was incessantly occupied with investigations of all kinds, and in troubled times could find diversion and consolation in research, he was not destined to spend his life quietly in the lecture room, or more variously with his patients or at court. Many things claimed his lively curiosity.

There was the case of the seven Lancashire witches he was called on to examine, to discover whether they actually had had intimate dealings with the devil or his minions. He could find no evidence of it and they were acquitted; but for three of them the acquittal came too late, for the miseries they had suffered had already proved fatal.

There were his travels. One who had spent four years at a foreign university must have remained something of a cosmopolitan, and Harvey had a zest for sight-seeing. In 1650 he was sent by Charles the First to accompany James Stuart, Duke of Lennox, on a European journey, and they were away over a year. In 1633 he accompanied King Charles himself to Scotland. In 1635 he was with the Earl of Arundel on a diplomatic mission to Vienna in connection with the Thirty Years' War, which was still dragging out its weary length. It was on this journey that Arundel wrote of him to Mr. Secretary Windbank, "Honest little Harvey is going on a little start into Italy, and I give him some employment to Mr. Pettye, about pictures for his Majesty," which suggests that "the little perpetual mov called Dr. Hervye", as Arundel calls him in another letter, is interested in art as well as science.

Letters written on these journeys both by his companions and by himself give a vivid impression of his personality. On the first of the journeys he writes to Viscount Dorchester:

> "I can only complain that by the way we could scarce see a dog, cow, kite, raven or any other bird or anything to anatomise, only some few miserable people, the relics of the war and the plague, where famine had made anatomies before I came . . . . It is the time to leave fighting when there is nothing to eat, nothing to be kept and nothing to be gotten."

On the second of the European journeys Wenceslaus Hollar, the artist, who was also in the ambassadorial train, complains of him:

> "Dr. Hervey would still be making observations of strange trees and plants, earths, etc., and sometimes like to be lost. So that my lord Ambassador would be really angry with him, for there was not only a danger of thieves but also of wild beasts."

Harvey himself, in the eleventh essay in his treatise on 'Development', gives an example of this passion for 'making observations' in a description of the birds on the Bass Rock, which he had turned aside to have a look at when he was in Scotland with King Charles.

On May 6th, 1636, Lord Arundel writes gaily of him from Cologne:

> "I have been this evening at the Jesuit's fair new church and college. I found in the college little Dr. Hervey who means to convert them."

evidently a reflexion on the sturdy Anglicanism of the little doctor. The smallness of his stature seems to have made a deep impression on Arundel, and it is possible to sense a warm affection in the frequent repetition of the word 'little', especially when it is accompanied by the other adjective so often attached to his name. 'Honest little Hervey' may well be a term of endearment as well as of admiration.

Harvey, writing to Lord Fielding, gives the impression that, intellectual though he was, he was no ascetic:

> "I have been twice or thrice a hunting with the Emperor. We drank hard and had many expressions of good wishes."

Then there was that dreadful incident on the way to Venice when, at Treviso, twenty miles away from his destination, he was "stayed and put in their lazaretto there to do his quarantina."

It was a time when the plague was one of the nightmares of Europe. The Italians, to their credit, had originated a system of *quarantina*—it had been *trentina*, or thirty days at first —and insisted that travellers should carry a *fede di sanita* or health certificate, which must be endorsed by the Podesta of every town they passed through. But the Podesta of Treviso was satisfied neither by the evidence of his *fede* from which some signature had been omitted, nor by the assurances of the Doctor himself, and on August 3rd Harvey was writing from Treviso to Lord Fielding in Venice:

> "I have recyved heare a very unjust affront, being stayed and commanded by this Podesta to have gone into the Lazaretto, without any cause of suspition alledged."

He deluged Lord Fielding with correspondence:

> "When your lordship shale marke how tedious I am in writing I pray give it this interpretation, I have noe other thinge to doe and infinite greedy to be gone."

Inactivity was the one thing he could not bear. And, physician as he was, he was the more alive to the dangers of infection, imperfectly understood though they then were:

> "It would be like the rest of ther proceedings yf they sent me an infected bed to make their conjectures and suspitions prove true: therefor I choose to lie still to be redeemed by your Excellency oute of this innocent straw."

It is the only sign in his writings or in those descriptive of him of the choler attributed to him by the gossip Aubrey, and Aubrey himself would have been the first to be annoyed if he had been "scribling on the grass in the feild" as Harvey was.

But as soon as it was over he dismissed it from his thoughts.

On September 7th, his visit to Venice accomplished, he writes his letter of thanks in a happy mood.

> "My sweete lord with many thanks I humbly present your Excellency for all the favours I have received att my being att Venice. . . . The Grand Duke his highness receyved my letters and me with greate curtesy, favour and respect; talked often long and familiarly with me, presented me with frute, fowle, wine, etc."

Harvey enjoyed not only the friendship and respect of kings and princes but also the esteem of members of his own profession. In three separate years he held the position of Censor to the College of Physicians, an important post that involved the judicial oversight of the profession. For nine years he was Treasurer of the College, and he was also one of the eight 'Elect' appointed to examine applicants for licences.

He was sixty-four years of age when the Civil War broke rudely into his busy life. He had been closely attached to the King's person ever since Charles the First had come to the throne, and as his Senior Physician he attended him to Scotland and York on the abortive peace-making journey of 1639; to Nottingham when the Royal Standard was raised and the army assembled in 1642; to the indecisive battlefield of Edgehill, where Aubrey reported that the young Princes were put in his care while the fighting went on, and that whilst he was reading in the shelter of a hedge a cannon ball passed alarmingly near to them.

He was too old for fighting, but he was part of the Royal Household, and as such attracted the fanatical attentions of the Parliamentarians, who ransacked his London house, destroyed his specimens and burnt his notebooks. The collection was reputed to be worth £20,000, and might well have been left to the nation, to form the nucleus of the British Museum, as did the collection of another physician, Sir Hans Sloane. He told Aubrey that "no grief was so crucifying to him as the loss of these papers, which for love or money he could never retrieve or obtain." They were the fruit of many years of "infinite labour and study", which he was too old to undertake again.

However, when the court settled in Oxford he was able to continue his researches for the work he had in hand, the treatise on 'Development', which was published in 1651 with the title of *Exercises on the Generation of Animals*. He examined the embryos of chickens at various stages of growth, and laying hens enlivened the precincts of Merton College, of which, during the Royalist occupation, he was made Warden.

When the Commonwealth forces entered Oxford he returned to London and to a large extent to retirement. But he was able to resume the Lumleian lectures, which had been neglected during his absence. He retained his interest in the College of Physicians, and expressed it in a very practical way. At Amen Corner, Paternoster Row, he built and equipped a library and museum, which was opened on February 2nd. 1653, with a sumptuous banquet at which he entertained the Fellows and Officers, and handed over to them the title deeds. Three years later he added to the gift the family estate at Burmarsh in Kent, which was worth £56 per annum and was to provide an annual feast—his dinners at Whitehall had given him a taste for good living, a Latin oration, a gratuity for the orator, and provision for the keeper of the library and museum.

He was offered the presidency of the College, but refused it with characteristic graciousness. He thanked his colleagues for the honour done him, but told them that the affairs of the College were too weighty to be entrusted to one "laden with years and infirm in health", and asked that he might be acquitted of arrogance in presuming to offer the advice that the late president, Dr. Prujean, should be reinstated.

Harvey was indeed an old man. The execution of the King and the defeat of the Royalist party must have been a great grief to him. His wife was dead, his sisters and three of his brothers also. He made his home, not uncomfortably, with his brother Eliab the tea merchant, who had prospered, and had houses both in town and in the country. It is surmised that Eliab had kept a brotherly eye on William's material affairs, for they were in a better state than might have been expected from the unsettled state of the country, his attachment to the King, and his preoccupation with his work.

About this time, Christmas of the year 1650, Dr. George Ent, one of the founder-members of the group that was eventually to become the Royal Society, sent news of him to the President and Fellows of the College of Physicians. He wrote:

> "I found him, Democritus like, busy with the study of natural things, his countenance cheerful, his mind serene, embracing all within its sphere. I forthwith saluted him and asked him if all were well with him? 'How can it be,' said he 'whilst the Commonwealth is full of distractions, and I myself am still in the open sea? And truly did I not find solace in my studies and a balm for my spirit in the memory of my observations of former years I should feel little desire for longer life. But so it has been, that this life of obcurity, this vacation from public business, which causes tedium and disgust to so many, has proved a sovereign remedy to me. . . . It is true the examination of the bodies of animals has always been my delight, and I have thought that we might thence not only obtain an insight into the higher mysteries of nature, but there perceive a kind of image or reflex of the omnipotent Creator himself."

This short account of William Harvey may fittingly close with an extract from the last of his extant letters. It is addressed to John Vlackveld, a physician at Haarlem, who had sent him an interesting specimen.

> "Nature is no where accustomed more openly to display her secret mysteries than in cases where she shows traces

> of her workings apart from the beaten path; nor is there any better way to advance the proper practice of medicine than to give our minds to the discovery of the usual law of nature by careful investigation of cases of rarer forms of disease. . . .
>
> But it is in vain that you apply the spur to urge me, at my present age, not mature merely but declining, to gird myself for any new investigation; for I now consider myself entitled to my discharge from duty. It will, however, always be a pleasant sight to see distinguished men like yourself engaged in this honourable arena."

This letter was written on the twenty-fourth of April, 1657. He was discharged from duty on the 3rd of June, and his remains were buried, at the direction of his brother Eliab, in the parish church of Hempstead in Essex.

CHAPTER SEVEN

The English Hippocrates

"*Such a man might be a copy to these younger times.*"
(ALL'S WELL THAT ENDS WELL)

WHILST Dr. Harvey, with mixed feelings of detachment and uneasiness, followed the fortunes of his sovereign at Edgehill, Thomas Sydenham, who had recently matriculated at Oxford, fought on the Parliamentarian side in the sieges and skirmishes with which the peace of his native Dorsetshire was interrupted. Harvey was sixty-four years old, Sydenham eighteen; the one at the height of his career, the other barely on its threshold. They were on opposite sides, and it is unlikely that they ever met, but they were the two greatest physicians of the century, and their contributions to the Art, different but complementary, were to point the way along which it was to develop.

Thomas Sydenham was born in the late summer of 1624 at Wynford Eagle in Dorsetshire, probably in the manor house built by his father William Sydenham in 1630 on an estate bought for forty pounds from John, Lord Zouch, in the thirty-sixth year of the reign of Henry the Eighth.

In a family of ten children he came seventh, and was the fifth boy. It was not a large family for the times, but so many infants died of smallpox, infantile diarrhoea, and other ailments due to dirt and infection that it was remarkable that nine of them reached maturity, and a tribute to the healthy country life they led. The gentleness apparent in Sydenham's portrait suggests that his early years were cheerful and happy, and that the Puritanism of his parents, staunch though it was, was not darkened by fanaticism. In later life, in spite of griefs and disasters, and the triumph of the opposite party, Thomas Sydenham was able to write, "God alone punishes. We, as best we can, must relieve"; such toleration is generally rooted in a kindly childhood.

Be that as it may, Puritanism was the deciding factor in his education, and he was sent to Magdalen Hall (now Hertford College) the popular Puritan college, of which Dr. Wilkinson, the leader of the Oxford Puritans, was Principal. But his stay was short. War broke out before he had well settled down to his studies, and when the Royalists were preparing to occupy Oxford he returned to Dorsetshire. His family were actively engaged on the Parliamentary side; his father, now nearly fifty, was a captain in the army, and four of his brothers also held commissions. Thomas, at the age of eighteen, and with no particular career as yet in view, was not likely to consider himself exempt from the 'misfortunes of the first war,' and he probably served in the engagements in which the parties fought for local supremacy in areas not occupied by the main armies. He might well consider it a time of misfortune, for his elder brother Francis was killed in action, and his mother died, shot, it was rumoured, deliberately, but more likely by accident, in some minor engagement near Wynford Eagle.

It was not until 1646 that Thomas Sydenham was able to return to Oxford. The court had left the year before, and Harvey, relinquishing the Wardenship of Merton, had gone back sadly to London, to find the exact extent of the loss inflicted on him by the Philistines. Meanwhile the Parliamentarians were looking round for scholars free from Royalist taint to occupy the seats of learning left vacant.

Thomas Sydenham was now twenty-two, and four years of fighting and unrest had interrupted his studies. It was not easy to take them up again, but at least he had decided on the direction they were to take. His career had not been mapped out for him by his father, as Harvey's was, and up to the time of his return to Oxford, apart from the fact that he did not regard his academic career as terminated, he had made no decision about his future, which up to this point had been less urgent than the present, from which it might well have been cut off by a cannon-ball. But fortunately fate, in the person of Dr. Thomas Coxe, took a kindly interest in the matter.

In a preface to his collected works, written in the form of a letter to Dr. John Mapletoft, Professor of Gresham College, London, he recalls the circumstances:

> "Thirty years ago, on my way to London, that I might go thence again to Oxford (from which the calamity of the first war had detained me for several years) I had the good fortune to meet with the most learned and ingenuous physician Master Thomas Coxe, (who at that time and until the present has practised medicine with great distinction) and who was then consulting with my brother, who was sick. He, with his well-known kindness and courtesy, enquired of me what profession I proposed to devote myself to now that I was returned to my interrupted studies and had assumed the 'toga virilis'. At the time I had not indeed made up my mind, nor even dreamed of the art of medicine. Moved by the exhortation and authority of such a man, and by I know not what of my own fate, I applied myself earnestly to that pursuit. And certainly if my endeavours have yielded the smallest usefulness to the public they must be referred with gratitude to the promotor and protector of my early studies."

It would be interesting to know the exact nature of these early studies, for they probably comprised the whole of his medical training. We know that they included no clinical experience, and we know that Latin was compulsory and was the language of the medical textbooks. After four years of disuse Sydenham's Latin was rusty, but he applied himself earnestly to it. His favourite author was Cicero, and he made a habit of translating his works into English, and then back again into Latin, checking his own version by the text. Exactly how fluent he became we do not know. It is thought by some that he wrote his own works in English and had them translated into Latin by one of his pupils. If this is so it is difficult to understand why Dr. John Pechy, the author of the earliest known English version, should have taken the trouble to translate them. A more acceptable supposition seems to be that the Latin Sydenham acquired at Oxford was adequate for his purpose, but that he had it checked and corrected before sending it to the printer.

Twice a week Sir Thomas Clayton, the Regius Professor of Medicine, delivered a lecture on the works of Galen and Hippocrates, and it was probably the case histories of the Hippocratic Corpus that first turned Sydenham's attention to the value of accurate bedside observation. But Hippocrates was more to him than an exponent of method. From what was known and from more that was imagined he created for himself a picture of 'the Divine Old Man', as he called him, that served him as an ideal so well that in time he came to be called 'the English Hippocrates', a title that would have pleased him more than any other.

In addition to lectures Sir Thomas Clayton, who was also Professor of Anatomy, as his father had been before him, was responsible for the anatomy course, which consisted officially of the dissection of the body of one newly-executed criminal a year. Unfortunately—or in the event perhaps it was fortunate—he was said to object to the sight of blood, which made him faint (Sydenham was to point out later, possibly with his case in mind, that men are subject to hysterical diseases as well as women); the anatomy lectures were therefore conducted by Dr. William Petty, who had studied anatomy on the continent, and who was later appointed to the Chair. It was at Dr. Petty's house in Oxford that the 'Philosophical Society' met. This was a branch of the Invisible College which, after the Restoration, received its charter as the Royal Society. It is not on record that Sydenham attended these meetings, or that he had any particular interest in contemporary scientific developments. His interest was to be found at the bedside of the patient, but his method was truly scientific in that it consisted in collecting and classifying accurate observations. "Only facts are the tests and touchstone of truth," he wrote in his essay on smallpox and hysteria.

In addition to lectures on ancient medicine and demonstrations in anatomy the University provided lectures on chemistry, which may have been attended by the medical student; and opportunity for some study of botany, centred in the Physick Garden, which was said to contain six hundred botanical specimens. But if we are to be guided by the account written by John Evelyn in 1654 of the Physick Garden and of the Anatomy Schole, neither anatomy nor botany seem to have been taken very seriously:

> "Then I led my wife . . . into the Physick or Anatomy Schole, adorned with some rarities of natural things, but nothing extraordinary save the skin of a jaccall, a rarely coloured jacatoo or prodigious large parrot, two humming birds, not much bigger than our humble bee, which I had not seen before that I remember"—strange objects for the furtherance of medical studies! But there were "Two skeletons which are finely cleaned and put together" in the Library of St. John's College.
>
> "Hence we went to the physick Garden, where the sensitive plant was shew'd us for a greate wonder. There grew canes, olive trees, rhubarb, but no extraordinary curiosities, besides very good fruit which, when the ladys had tasted we returned in our coach to our lodging."

And we are left wondering whether the medical students learned much more than the ladies.

Perhaps the greatest benefit to be derived from residence in the University was from the discussions and conversations that went on amongst some of the greatest intellectuals of the age. There were in residence at about this time Boyle and Hooke and John Locke, and 'that prodigious young scholar

Mr. Christopher Wren'; then there were the doctors, Dr. Jonathan Goddard, Physician to Oliver Cromwell and Harvey's successor as Warden of Merton, Dr. Thomas Millington, afterwards President of the College of Physicians, and Dr. Thomas Willis.

But when all is added up it must be admitted that when Thomas Sydenham, on the 14th April, 1648, after less than two years of study at Wadham College, took his medical degree, his qualifications must have been very meagre. Oxford had no great reputation in medicine to keep up. It is on record that in 1555 Simon Ludford and David Laughton received medical degrees from the University, the one an apothecary, the other a coppersmith, and both of them ignorant and unlettered. Protests were indeed made by the College of Physicians, for since receiving their charter their own standard had been a little higher, and it was no longer possible in London for "ignorant persons, of whom the greater part had no insight into physic, nor in any other kind of learning" . . . for "common artificers, as smiths weavers and women" to take upon themselves great cures "to the grievous hurt, damage and destruction of many of the King's liege people."

The standard of the Oxford M.B. was no doubt higher in 1648 than it had been in 1555, and it required the influence, indeed the command, of the Earl of Pembroke (scarcely an authority on medical requirements) before Sydenham could become a Bachelor of Medicine. The fact was that since so many scholars of Royalist sympathies had been expelled there was a dearth of Fellows, and since it was not possible to appoint a Fellow who had no degree the process was accelerated. In accordance with this policy Sydenham left Wadham in the autumn of 1648 to become a Fellow of All Souls, and in the following spring became Bursar of the College, positions he held until his marriage in 1655. Most of this time was spent in the continuance of his studies, but they suffered a short interruption in 1650-51 when Charles the Second landed in Scotland and the Commonwealth forces marched to meet him. On this occasion Thomas Sydenham served in the militia not as a doctor but as a captain of cavalry, and one is tempted to wonder whether the choice, if choice there were, was dictated by distrust of his qualifications or the opportunity to indulge in his favourite exercise of horse-riding.

In 1655 he married Mary Gee. He was now thirty-one, and if he was to make a career for himself it would seem that no time was to be lost. But there is evidence of some hesitation. He gave up his Fellowship and took a house in King Street, Westminster, then a marshy neighbourhood where fevers were endemic, but conveniently near the Protector's court at Whitehall, where he might hope to find patients. He had some recently acquired capital, for he had successfully applied for the reimbursement of moneys lent to his brother for military equipment, to which he felt he was particularly entitled in view of his own recent services as a cavalry captain. He was granted £600, a considerable sum and very convenient to tide him over the early expenses of practice. But for a few years he appears to have wavered on the brink of public life, his interest in politics not yet ousted by his devotion to medicine. He became a candidate for Parliament, but was unsuccessful; and he was appointed by the now half-forgotten Richard Cromwell to the very minor post of 'Comptroller of the Pipe' in the Court of Exchequer.

But Cromwell was dead and the Restoration was imminent. His appointment lapsed and the political field was closed to him; in the practice of his chosen profession, however, he was unmolested. In view of his other activities it seems probable that he had made no great headway in his first five years in London. He was conscious of the deficiencies of his training, and like many another young doctor he probably felt that he had everything to learn. Years later he could smile at his failures when he wrote in his *Treatise of the Gout and the Dropsie*.

"I remember very well (for this was my first Hydropic

> Patient) 27 years ago or thereabout I was called to Westminster to one Mrs. Saltmarsh, an honest and pious gentlewoman" whom he dosed with Syrup of Buckthorn "and she perfectly recovered, and I with the juvenile confidence of an unexperienced man verily believed that I had got a medicine that would cure any manner of Dropsie: But I found my mistake within a few weeks, for soon after I was called to another woman that had the same Disease" whom he treated in the same manner, but with less success "and the Sick dismissed me, and as I remembered recovered by the Assistance of another Physician, who prescribed more effectual Remedies."

The English translation is by Dr. John Pechey, whose 'excellent purging pills' were sold in the year 1695 at his house at the Angel and Crown. But, in spite of the quaint expression, the experience will sound a familiar note to the young physician who now sets out on his career with a wealth of clinical experience undreamed of by Dr. Sydenham.

It is conjectured that at about the time of the Restoration Sydenham went to Montpellier for six months of study, but there is no evidence of it other than probability. He may have thought it safer to be out of the way for a while, for his name could not have been a welcome one in Royalist ears. His eldest brother William was among the few excepted from the general amnesty. But he died in 1661, and old William Sydenham died too, leaving Thomas now the sole survivor of the family. And whatever he may have done during the rejoicings of the Restoration year, in the year 1661 he was undoubtedly settled in gay and Royalist London, engaged in his study 'Of the Continual Fever' that brooded over its insanitary ways.

He had as yet no licence to practise. The regulations of the College of Physicians had not been recently enforced, but with the prospect of more peaceful times ahead it is possible that Sydenham was reminded of his omission. He took the three obligatory examinations and was admitted Licenciate on June

25th, 1663, at the age of thirty-nine. He never became a Fellow of the College. That would have required a Doctor's degree, which he did not possess until the age of fifty-two, which was then considered the verge of old age. What might be called his 'paper qualifications' remained meagre to the end, a fact that may afford comfort and encouragement to the medical man who has never gained much academic distinction but may yet be an outstanding physician in the true Sydenham tradition.

And what, it may be asked, was the Sydenham tradition? In what way did he differ from his contemporaries?

In the first place in his devotion to his profession. He regarded it not so much as a career but as a means of serving mankind. In his epistle to the 'learned and accomplished Dr. Brady' which prefaced his account of *Epidemical Diseases* from the year 1675 to the year 1680 he wrote:

> "I . . . have always thought, and not without reason, that there is more happiness in discovering a certain method of curing, tho' but of the least Disease, than in heaping up the Treasures of Tantalus or of Croesus. More happiness I say, and more wisdom too; for what better specimen can any one show of his wisdom and goodness than to do continually all he can rather for the public good, (he being part of the common Nature of Mankind,) than for himself, he being so small and contemptible a part of the whole?"

We have only to look back to the Doctours of Phisyk to see what a revolution in attitude this is; or even, the better to point the contrast, to his contemporaries, of whom a certain Dr. Gideon Harvey, Physician to the Tower, wrote "Physicians of the present day are like Balaam's ass, they will not speak until they see an angel"—an angel being a ten-shilling piece in the currency of the period.

It was not only his attitude to his profession that was unusual, but also his outlook on disease. He regarded diseases as entities that could be differentiated and classified, like plants and animals. Each case was not in every way typical, any more than every dog has all the characteristics of its breed, but a sufficient number of characteristics were present to place it in a definite category. In order to recognise and classify a disease its cause, onset, symptoms, and course must be considered; and it was the physician's business, as Sydenham saw saw it, to observe and chronicle these phases, together with the effect of the treatment given, so that eventually the best treatment might be discovered and universally applied. Not for him the locked book of secret nostrums. The treatment he prescribed was written down, to be compared with that of others for the benefit of posterity.

> "I think our Art may be best improved," he wrote, "first by a History and Description of all diseases as graphically and naturally as possibly may be, and secondly by a perfect and stable Practice or Method Respecting them . . . I have labour'd to the utmost of my Power . . . that the Cure of Diseases may be managed after I am dead with greater certainty, esteeming any progress in this kind of knowledge, how small soever it be, though it teach us no more than the cure of a Toothache, or of Corns, to be more valued than the vain Pomp of nice Speculations which are no more useful to a Physician on the cure of Diseases, than Skill in Musick to a Carpenter in Building."

He fully realised the difficulty of the task he had set himself. He was not proposing to write a diary of superficial sick-room gossip; his intention was to record and classify his bedside observations in the new scientific manner that he had not so much learned as invented. He wrote:

> "It is indeed very easy to describe diseases grossly: but so to write the History of them that the censure of my

> Lord Bacon may be avoided, whereby he chastises some such promises is much more difficult."

From the very beginning of his practice in Westminster he must have made a habit of sitting by his patient, notebook in hand, or observing with such intensity that the minutest particulars were registered faithfully in his memory for future recording. We can imagine him thinking out his cases as he bumped over the cobbles in his coach, marshalling the facts that were to be written down so that the cure of diseases might be better managed in times that he would not live to see. In his *Treatise of the Gout and Dropsie* he gives us a picture of his daily routine, not indeed for gossip's sake but to demonstrate how a man with gout might keep his disease at bay with moderate living.

> "In the morning when I rise I drink a dish or two of Tea, and then ride in my Coach till Noon; when I return home I moderately refresh myself with any sort of Meat of easy Digestion that I like; (for moderation is necessary above all things.) I drink somewhat more than a quarter of a Pint of Canary-wine, presently after Dinner every day, to promote the Concoction of the Meat in my Stomach, and to drive the Gout from my Bowels. When I have Dined, I betake myself to my Coach again, and when business will permit, I ride into the Country two or three Miles for good Air. A draught of Small Beer is to me instead of a Supper and I take another draught when I am in Bed, and about to compose myself to sleep . . . I take care to go to bed early, especially in the Winter, than which nothing is better to perfect concoction, and to preserve the form and order which duly belongs to Nature; whereas, on the contrary, night-works lessen all the concoctions of old men and dangerously wounds their vital Principle."

He was an old man when he wrote this, but for a busy general practitioner the daily routine does not vary much through the years. In his younger days he may have done his rounds on horseback as Harvey did, riding on a horse cloth. It was a form of exercise he frequently recommended to his patients. In his treatise on the Stone he writes:

> "I have observed for myself that long and daily exercise does not only hinder the generation of this stony matter; but also dissolve the stones when they are hard and old. . . . As to the kind of exercise, riding on Horse-back, when Old-age or the Stone does not hinder, is much to be preferred before the rest; and truly, I have many times thought with myself, that if anyone knew a medicine which he could also conceal, as effectual as this for most Chronical Diseases, as constant and daily riding on horse-back, he might easily get a vast estate. If this cannot be used, riding in a coach does almost as well; and on this account at least it is well with gouty people, for their riches which enticed them to Luxury, whereby the Disease was bred, can provide them a Coach, which kind of Exercise they may use when they cannot the other."

This long and daily exercise suggests that his practice was a large one, and it would be interesting to know how often he was able to turn from the slippery cobbles and undrained streets of London to the sweeter air of such villages as Chiswick by the river-side or Hampstead on its bird-haunted heath.

In 1667 he moved from King Street to Pall Mall, then newly built. His house was close to the present site of the Royal College of Physicians, and overlooked St. James's Park, where the purer air brought him a breath of the countryside. Next door to him lived his friend Daniel Malthus, the apothecary, in a shop over which hung the sign of the Pestle and Mortar.

He had been married now more than twelve years, and had three sons. It is evident that he was a devoted father, for a fatherly tenderness is discernible in all his writings about the treatment of children. In his *Method of Curing Fevers*, which was published in 1666, he mentions his eldest son "whose life and safety he held of more importance than all the wealthe of the Indies", and it was not his habit to use words lightly. One of his sons was to follow in his father's profession, and for him he wrote a little handbook of medicine small enough to be carried in the pocket, entitled *Dr. Sydenham's Practice of Physic.*

Besides the three boys and their mother, of whom, unfortunately we know nothing, the household in Pall Mall included his mother-in-law, Mrs. Gee, and various young medicals as student-assistants. One of these was Hans Sloane, who, in spite of the fun poked by Sydenham at riches and all their evil consequences, became one of London's wealthiest and most sought-after physicians. Much of his wealth was invested in real estate in what were then the outskirts of London, Sloane Square, Hans Place and their neighbourhood, and much was spent on the collection of *objets d'art* and specimens of various kinds, which are now to be seen in the British Museum.

Another of Sydenham's pupils was Doctor Dover, still remembered for his famous powders, and another was Bartholomew Beale, son of the artist, Mary Beale, to whom we are indebted for Sydenham's portrait. It shows a squarish face, with a broad brow and full, rounded chin. The eyes are large and well spaced. It is interesting to compare them with the eyes in Harvey's portrait, for whilst Harvey's eyes flash with an unusual brilliance Sydenham's glow softly with a gentle tranquillity that had its source in the deliberate choice of modest service: "Having nicely weighed whether it is better to be beneficial to men, or to be praised by them, I find the first preponderates and much conduces to the Tranquility of mind." The mouth is curved and full, the corners lifted a little, as by a habit of quiet smiling. Remembering his Puritan connections we look for something sterner, but it is not there. He might well have just remarked, "If we reject all cases of affliction which the improvidence of human beings has brought upon themselves there will be but little room left for the exercise of mutual love and charity."

The household in Pall Mall must have been cheerful and lively, but it was not of the kind to make history. Compared with Harvey's life of travel and incident, Sydenham's, after the Restoration, was uneventful. The years of war were over. Though the Plague ravaged London, and fire reduced large areas to ashes, Charles the Second balanced himself cautiously on the throne for a quarter of a century, and during the same period Sydenham, unconcerned now with politics and untroubled by other people's religion, or lack of it, went quietly about his work, visiting his patients, watching with an unusually observant eye the course of their diseases, and issuing from time to time the monographs that set a standard for medical research of the future. It appeared to him obvious that:

> "It is the part of a wicked man to destroy man, but the Duty of a good man to preserve them and to instruct others, so as that they may be able to free them from Death, after he is dead."

He had suffered from gout from the age of about thirty, and he classed it as a luxury disease, for which an essential of treatment was plain living. But he was no ascetic. He lived comfortably, kept his coach and horses, acquired estates in Hertfordshire and Leicestershire, and was able to drink every morning tea that cost anything between twenty-five shillings and three guineas a pound. He was a man of his time, and much of the treatment he prescribed did not differ greatly from that of his colleagues. But he qualified it by common sense that was profound enough to be uncommon. Vomits, purges and even bleeding he accepted as normal remedies, but he was less inclined to overdo them. "When I am called in to Patients whose Blood of itself is weak . . . I forbear Bleeding", an unusual proceeding, even in the circumstances. Again in

Scarlet Fever "I forbear bleeding and the use of Glysters . . . and I also, on the other hand forbear giving cordials. . . . If we disturb nature more, either by keeping the sick continually in bed, or by Cordials and other needless remedies too learnedly, and as it commonly appears thrust in above measure, Secundum Artem; the Disease is presently heightened, and the Sick dies by the over officiousness of his physician" as poor Charles the Second probably did. "Some symptoms," he remarks drily elsewhere "rather proceed from the physician than from the disease."

It was the fashion of the time to treat fevers by increasing rather than decreasing their violence, and many a patient must have been grateful for his temperate advice:

> "I take care that he lie not hotter, nor with more Cloaths on him than when he was in health, and that he have a fire kindled only morning and evening unless it be Winter."

If, on the other hand, the patient was chilly, warmth was supplied, though in a manner that nowadays appears a little shocking, especially when the dangers of infection are considered.

> "I have applied the vigourous heat of young people to the patient,"

writes Sydenham, and we wonder why he had not thought of a hot-water-bottle, until we remember that, with earthenware still a rarity and rubber undiscovered, the problem of local application of heat was considerable. For the iliac passion, which was characterised by acute abdominal pain, a live 'Kitling' was to lie upon the naked belly, "nor is the Kitling to be removed before the patient has taken the Pills."

Treatment of this kind reminds us how naïve much of seventeenth-century physic was. And yet at times Sydenham could leave it far behind. Apart from the small beer there is little to differentiate his treatment of the children of the Countess of Salisbury—who would have paid without murmuring for expensive medicine—from that of the family doctor of the twentieth century. In February, 1674, one of them developed measles:

> "and presently the rest (they were five or six) . . . I ordered them to keep their beds two or three days before the eruption. . . . but I did not permit that they should have any more Cloaths on or Fire than they used to have when they were well: I forbad the eating of flesh, and allowed them Oatmeal and Barley Broaths, and now and then a roasted Apple: and for their drink small beer, and Milk boyled with three parts of water; and when the cough was troublesome, as was usual I prescribed a Pectoral Ptisan to be taken often; they recovered with this method in the short time this disease is wont to finish its course."

and, he might have added, without the suffering that might have been inflicted on them by many of his over-zealous contemporaries.

In an "Epistolary Discourse" on those diseases "called hysteric in women and hypochondriac in men," addressed to Dr. William Cole, his acute penetration gives him the right to a place beside the modern psychiatrist. It is true that his observations are now a commonplace in mental treatment, but they have not yet been assimilated by everybody, and least of all by the potential patient. Explaining the origin of the word hysteric in the Greek ὑστέρα, womb, he writes:

> "Very few women, which sex is the half of grown people, are quite free from every assault of this disease, excepting those who, being accustomed to labour live hardly; yea,

> many men that live sedentary lives and are wont to study hard are afflicted with the same disease; and tho' hysteric symptoms were always heretofore supposed to come from a vicious womb yet if we compare Hypochondriack Symptoms . . . an egg is scarce more like an egg than these symptoms are to one another in all respects. But it must be confessed that women are much more inclined to this disease than men. Nor is this disease only frequent but so strangely various that it resembles almost all the diseases poor mortals are inclined to . . . and unless the physician is very skilful he will be mistaken and think those Symptoms come from some essential distemper of this or that part and not from an hysteric disease."

He goes on to describe his treatment of "an ingenious gentleman" who was afflicted with frequent and surely embarrassing attacks of weeping. He found that "the symptom was wholly produced by Emptiness, and therefore I ordered that a roasted Chick should be provided for his dinner, and that he should drink wine moderately", with the result that "he was never afterwards troubled with this convulsive weeping." But he fully realised that the physician must go warily in such cases, and friends and relations would be saved some trouble by the realisation that hysterical subjects "are very angry when any one speaks never so little hopes he has of their recovery." He might have gone on to remark that a miraculous cure that still keeps the patient in the limelight might nevertheless prove acceptable.

There was one disease on which Sydenham had pretty well the last word. His gout was painful and irritating and inconvenient, and as he grew older it cut him off from his favourite exercise, but it gave him an invaluable opportunity to study it in all its phases, and his *Treatise of the Gout and Dropsie,* gathered largely from his own experience, contains the classical ion of the disease. He was always apologetic for being

> "Perchance it may seem ridiculous (especially for one, who's being well or dead is scarce worth minding) to make such frequent mention of himself, yet these things are said, to the intent others may be benefitted thereby, whose Lives, or Health are of greater moment."

He was getting old, and like others who have survived their nearest and dearest he was lonely. But he found solace in writing, as he explained to Dr. Cole:

> "I must confess there is another Cause besides the hopes of doing good to the Publick, viz. that I might employ my spare time well, and pass away honestly the tedious long winter evenings, for by reason of my Age I cannot longer seek companions abroad."

He finished his treatise *Of a Bloody Urine from a Stone in the Kidneys*, "And this is in a manner the Sum of all which I have hitherto known concerning the Cure of Diseases, viz. to the 29th of September, 1686." It was a generous contribution, and greater than he knew. On December 29th, 1689, at the age of sixty-five, his life, so honestly and usefully employed, came to an end. He had translated into modern terms the ideal physician first sketched, but much more roughly, in the Hippocratic writings; he had turned medical attention to the scientific study of disease, and he had written medical monographs that set the pattern for all time. The inscription that was on his tomb in St. James's Piccadilly does not seem excessive. It has been lost in the destruction of war, but the broken stones are being reassembled, and before long we may hope to be able to read again his epitaph:

Medicus in Omne Aevum Nobilis.

CHAPTER EIGHT

A Gloucestershire Surgeon

> *"He lived at a time when the whole of the civilised world was ravaged by a war of almost unequalled ferocity. Before he left the stage he had the supreme gratification of knowing that his discovery had been the means of saving more millions of lives than had been sacrificed during the murderous conflict."*
>
> (JOHN BARON)

EMERGING by slow degrees from mediæval obscurantism the art of medicine was advancing along two ways, one, the more narrowly scientific, in laboratory and anatomy theatre, the other, none the less scientific because precision was more difficult, by the bedside of the patient. Although charlatans and quacks still flourished, they were beset by an increasing mass of knowledge accumulated by conscientious practitioners. Physician and surgeon knew more about the body and its functions, and they knew more about disease. The patient received considerably better treatment, but its aim was, for the most part, restricted to the palliation of symptoms. From time to time plague, typhus, cholera, and smallpox decimated populations; syphilis and tuberculosis took their toll; and wars were lost or won by the diseases that attacked the armies, whether victorious or defeated. No one had, as yet, conquered a disease, and nature was allowed to pursue her prodigal way, intent only that life should go on, regardless of cost.

The first disease to be conquered was smallpox, and the man who made its conquest possible was an obscure country practitioner who had a gift for noticing with lively interest things that others passed over as commonplace, and who learnt from John Hunter the nature and value of experiment.

The fear of smallpox has been so completely banished that it is difficult nowadays to realise what a haunting dread it once was. It is not possible to quote very reliable figures, for in the seventeenth-century statistics were in their infancy, but those available serve at least to give a graphic idea of the place of smallpox in the apprehensions of men and women alike. The *Gloucester Journal* of February the 23rd, 1823, in an obituary notice of Doctor Jenner, stated that 40,000 people died annually from smallpox in the British Isles, that it killed one in fourteen of all that were born, and one in six of all that contracted it 'in the natural way'—that is to say not by being inoculated with it. Nor was fear of death the only evil. There was also the dread of disfigurement. For all townswomen who were not servants marriage was the only respectable career, and in the marriage market beauty was second only to property. What chance, then, had a pock-marked woman of making a suitable match? Jenner himself relates in one of his note-books how "the Duchess of Cleveland was taunted by her companions, Moll Davis . . . and others, that she might soon have to deplore the loss of that beauty which was then her boast, the smallpox at that time raging in London. . . ." To the beauty the spectre of disfigurement was as dreadful as that of death.

Attempts had been made to disarm the haunting terror. It had been observed that a second attack of smallpox was rare, and also that some epidemics were of a milder nature than others. Was it not preferable, then, to have the disease when it occurred in a mild form rather than run the risk of it in a severe one? In several countries methods had been invented of communicating what it was always hoped would be a mild attack of the disease. In eighteenth-century England inoculation, or 'variolation', was rapidly becoming general. It had been popularised by Lady Mary Wortley Montague, who had seen it practised by the Turks when, early in the century, her husband had been Ambassador in Constantinople. She was a woman of great energy and enterprise, and was so convinced of its efficacy that she had her son inoculated in Constantinople, and when she returned to England advocated the same treatment for the Royal Family. George the First, with due caution, had it tried out on seven prisoners of Newgate and six orphan children, who were subsequently exposed to infection, to which they showed themselves immune. The experiment was reasonably convincing, and two children of the Princess of Wales were inoculated. Smallpox was no respecter of persons, as the House of Hanover well knew. Half a century earlier Charles the Second had lost a sister and a brother from the disease, leaving no alternative to the succession but the unwelcome James.

Others soon followed the royal example. Smallpox hospitals began to make a practice of variolation, and 'inoculators' set up in what became a profitable business. The most famous of them was Daniel Sutton, who, from 1763 to 1796, treated patients at Ingatestone in Essex, preceding the operation with frequent purgings, bleeding, and low diet, for which it is difficult to see any justification, but which nevertheless was the accepted practice.

The usual method of inoculation was to soak a thread in the pus of a smallpox pustule, make a small incision in the arm, and bandage the infected thread to the wound. Frequently the resultant attack of smallpox was a mild one. Possibly the drying of the thread reduced the virulence of the infection, and as the disease took some time to develop when communicated in this way, resistance to it had time to develop too. But the attack was not always mild, and there was a proportion of deaths which has been calculated at about two per cent. At the same time the spread of infection increased the incidence of the disease and the ravages of smallpox grew rather than diminished. As the *Gloucester Journal* put it, "though it augmented the individual security, it is a well ascertained fact, that it added to the general mortality, by multiplying the sources of contagion, and thereby increasing the number of those who became affected with the natural distemper."

Variolation, then, was a failure, but it served one invaluable purpose. It directed the attention of Edward Jenner to the possibility of protection—the word immunisation is of later date—by inoculation with cowpox.

Edward Jenner was a country surgeon. This does not mean that he practised surgery only. All that the title implies is that he was not a university man, and, until he had been in practice for twenty years, he did not possess a medical degree. He was born at the old vicarage of Berkeley, a small market town in Gloucestershire, on the 17th of May, 1749. His father, the Rev. Stephen Jenner, was Rector of Rockhampton and Vicar of Berkeley, and his mother had been brought up in the same vicarage, for she was the daughter of the previous vicar, the Rev. Henry Head, who had since moved to the neighbouring county of Berkshire. The patron of the living was the Earl of Berkeley, who lived in the near-by castle, and became one of Doctor Jenner's patients. Jenner's two elder brothers, Stephen and Henry, were both to enter the Church, and to become, each in his turn, Rector of Rockhampton. It was the rural society that Jane Austen was to preserve for us in faultless miniature, and only Edward Jenner himself would have proved too large for her exquisite brush.

There were three sisters as well as the three brothers, and for a few years the old vicarage of Berkeley contained a happy and lively family. Discipline such as we imagine invariably afflicted our forebears was evidently absent, for in later years Edward Jenner was to write to his old friend John Clinch, "Severity to children I utterly abhor, and my observation leads me to consider it as being more injurious to them than the contrary extreme, but either one or the other is so hurtful to the mind that we feel its baneful effects to the very latest period of our lives." There was no evidence of the 'baneful effects' of either extreme on his frank and friendly disposition, and even the early loss of his parents did not leave any damaging marks on his character, unless in his acute sensitiveness to both joy and sorrow.

He was only five years old when his father died, and he went to live with his elder brother Stephen, who looked after him with affectionate care. At the age of eight he was sent to a school kept by the Rev. Mr. Clissold a few miles away at Wotton-under-Edge. He wrote of his education some years later: "In my youth I went through the ordinary course of a classical education, obtained a tolerable proficiency in the Latin language, and got a decent smattering of the Greek; but the greater part of it has long since transmigrated into heads better suited for its cultivation."

If this was true of his Greek and Latin it was certainly not true of his interest in natural history, which he does not include in his account of his education. This interest developed early and remained with him throughout his life. At Wotton he collected dormouse nests, and when he went on to a school at Cirencester, kept by the Rev. Dr. Washburn, he made a collection of fossils, which were plentiful in the oölitic formations of the district. He must have studied music, too, for we know that he played both the violin and the flute and was always ready to take his part in a catch or sing a song. Being so closely connected with the Church he possibly began his musical education as a choirboy.

At the age of thirteen, already proficient in Latin and with a smattering of Greek, his formal education came to an end. He was to be a doctor, that was decided for him, and he was apprenticed to Mr. Ludlow, a surgeon of Sodbury, near Bristol, to learn his profession, as was still the custom, in a practical manner. When, in 1815, the honorary degree of M.D. was conferred on him by the University of Oxford he comments on this absence of academic education: "It is remarkable that I should have been the only one of a long line of ancestors and relations who was not educated at Oxford. They were determined to turn me into the meadows instead of allowing me to flourish in the groves of Academus. It is better, perhaps, as it is."

During his seven years with Mr. Ludlow he learnt a good deal in the meadows, and he probably learnt as much of medicine as Doctor Sydenham had learnt at Oxford. Above all, he learnt to observe accurately and without prejudice. And two events of immense importance impressed themselves on his retentive memory. The first was his inoculation with smallpox, of which he wrote later: "There was bleeding till the blood was thin, purging till the body was wasted to a skeleton, and starving on vegetable diet to keep it so." He remembered it with horror. The second was the casual remark of a country girl, who was being attended by Mr. Ludlow, to the effect that she was not afraid of catching smallpox because she had already had the cowpox. He wondered if it was true that the one disease precluded the other. Later on, Hunter was to teach him: "Don't speculate. Make the experiment."

He met Hunter when, his apprenticeship ended, he went up to London for the two years of study that made up the whole of his formal medical education.

Dr. John Hunter was then a surgeon at St. George's Hospital, and he accommodated in his house a number of pupils, who attended classes held in the school of medicine in Great Windmill Street. Hunter himself had received no academic education, indeed little education of any kind; his knowledge of surgery and anatomy had been gained from helping his brother William, who was a successful teacher as well as a successful surgeon; and, more significantly, from his own innumerable experiments. With a mind unobscured by prejudice acquired from didactic teaching, he was above all things a scientist. He set out to investigate, more particularly in the realms of comparative anatomy and pathology, and in the then novel but now accepted fashion he devised experiments to test the truth of his discoveries. John Baron, in his Life of Jenner, wrote of him: "He was not less vigilant in his observation, than he was scrupulous and accurate in his examination, of the objects of his studies. He became thereby a penetrating and original thinker, and being at the same time gifted with much enterprise and perseverance, he mastered difficulties which for ever would have obstructed the progress of inferior minds."

In the young Jenner he found a kindred spirit, and in spite of the difference in age—Jenner was twenty, Hunter already forty—the two remained close friends until Hunter's death in 1793. The stimulus of his vigorous mind had a considerable influence on the pattern, if not on the actual direction, of Jenner's investigations. It was from Hunter he learnt how to devise experiments to isolate and prove significant facts. "They who are not in the habit of conducting experiments may not be aware of the coincidence of circumstance necessary for their being managed so as to prove perfectly decisive," wrote Jenner in the *Inquiry* and the words were an echo of his teacher's. Jenner always referred to him as 'the dear man', and for twenty years they kept up a correspondence delightful in its informality, its richness of interests, and the deep affection that inspired it. Hunter's letters to Jenner were docketed and preserved; Jenner's to Hunter, were unfortunately subsequently destroyed, leaving for us only a one-sided correspondence.

Whilst Jenner was living with Hunter, Captain Cook returned from his first voyage to 'the great southern continent', and it was at Hunter's suggestion that Jenner was employed to arrange and preserve the natural history specimens collected on the voyage by Sir Joseph Banks. This was accomplished with such care and skill that he was offered the post of naturalist to the expedition that sailed in 1772.

But Jenner's heart was still in the lovely country of Gloucestershire, where he had spent his childhood and youth, and where only he could find happiness, for he was both by nature and upbringing part of the interwoven fabric of English country life.

During his two years in London he had acquired various certificates, three of which are still in existence: one, signed by William Hunter on the 15th May, 1772, records that he had attended four courses in anatomy and surgery; another, signed by G. Fordyce on the 1st December, 1772, that he had attended three courses each of physick, materia medica, and chemistry; and a third, signed by Thomas Denman and William Watson in the same month, that he had attended a course of lectures on the theory and practice of midwifery. According to the standards of the time he was, although not a doctor in the narrower sense of the word, adequately equipped for carrying on the practice of a surgeon, which, in its actual requirements was not very different.

And he had had enough of London smoke, which, he wrote later, "I have observed is too apt to cloud our best faculties." Neither Cook's expedition nor Hunter's companionship could tempt him, and he returned to live with his brother Stephen, and carry on, in the country around Berkeley, the practice which he was to leave only for a few months at a time in the next half century.

We have a picture of him at about this period from the pen of his friend Edward Gardner:

> "His height was rather under the middle size, his person was robust, but active and well formed. In his dress he was particularly neat, and everything about him showed the man intent and serious, and well prepared to meet the duties of his calling. . . . . He was dressed in a blue coat and yellow buttons, buckskins, well-polished jockey boots, with handsome silver spurs, and he carried a smart whip with a silver handle. His hair, after the fashion of the time, was done up in a club, and he wore a broad-brimmed hat.
>
> We were introduced . . . and I was delighted and astonished. I was prepared to find an accomplished man, and all the country spoke of him as a skilful surgeon and a great naturalist, but I did not expect to find him so much at home on other matters."

Not for him the narrow interest of the specialist. To his profession he was indeed devoted, and for him as for Sydenham it was his service to mankind. But nature for Jenner was not exclusively human nature. He was acutely aware of those around him, but he was equally acutely aware of the teeming life in the fields and woods amongst which he had grown up. "In natural history, in particular," wrote his friend and biographer Baron, "he wished from his earliest years to show how much information and amusement lie scattered around us . . . and how desirable it is that all should be taught to taste them."

Then there were the 'other matters' in which he was almost equally at home. He wrote verses, he composed songs and sang them at convivial gatherings, he played the flute and the violin, he was a member of a catch club, and arranged little musical parties; he was interested in gardening, and grew roses, and, in the way of gardeners the world over, he exchanged plants and cuttings amongst friends and patients. He collected pictures, which Hunter, who also took an interest in art, sometimes bought for him. On one occasion Hunter wrote:

> "Pictures have been very cheap, but the season is now over. There will be but one sale, viz. Fordyce's; but I believe all his pictures are exquisite and will go beyond you or me. Since you wrote to me I purchased up a small landscape of Barrett's, of cattle and herd; I gave five pounds, seven shillings and sixpence. . . . You shall have it or not as you please."

The only diversion that seems to have failed to interest him was cards, which he regarded as a waste of time.

Small wonder that among his many gifts he possessed superlatively the gift of friendship. Even his school friends remained friends for life. John Clinch, beside whom in inky-fingered days he had learnt his Latin declensions, and who studied with him for a short time in London, remained equally his friend when he became a missionary in Newfoundland and the Atlantic separated them. Jenner was godfather to one of his children, and when his own child Edward was born wrote: "I ardently hope there may as much affection subsist between the young

Edward Jenners as between their fathers . . . there will be no room for more."

Another life-long friend was Henry Hicks; Edward Gardner has already been mentioned. Then there were his colleagues, and among them his 'dear friend Dr. Reed' of Cheltenham, to whom he dedicated the *Inquiry*. At Clapton Farm there was his Aunt Deborah; his brothers and sisters and their families were within riding distance, and to all of them he was devoted. And there were neighbours for miles around, gentry, farmers, and simple country folk. To all of them his blue coat and broad-brimmed hat as he threaded his way along the bridle paths 'point device in his accoutrements' must have been a welcome sight.

Sometimes he would cover thirty miles in a morning, but he seldom rode alone. Friends rode with him for the delight of his company and conversation, and for his host to accompany him on his way home from a distant visit was regarded as a privilege rather than as a courtesy.

But it was not always summer in Gloucestershire, and patients must be visited in snow and rain as well as in sunshine. He describes one such wintry visit, which, although it was probably the worst experience of the kind he encountered, serves well to illustrate the inevitable discomforts of a country practice:

> "I was under the necessity of going from hence to Kingscote. The air felt more intensely cold than I ever remember to have experienced it. The ground was deeply covered in snow and it blew a hurricane accompanied with continual snow. Being well clothed I did not find the cold make much impression upon me till I ascended the hills, and then I began to feel myself benumbed. There was no possibility of keeping the snow from driving under my hat, so that half my face and neck was, for a long time, wrapt in ice . . . I felt, as it were, like one intoxicated, and could not forbear singing etc. My hands

> at last grew extremely painful, and this distressed my spirits in some degree. When I came to the house I was unable to dismount without assistance. I was almost senseless; but I had just recollection and power enough to prevent the servants from bringing me to a fire. . . ." and so he was recovered, bit by bit, in the stables, but his "horse lost part of the cuticle and hair at the upper part of the neck, and also from his ears . . . . One man perished a few miles from Kingscote, at the same time and from the same cause."

A nature such as his, generous and unreserved, had no armour against arrows directed against the affections. "I once thought myself the most perfect animal mimosa living," he wrote ruefully. It was only too true, and a harsh touch that for a time shrivelled his gay spirits was that of unrequited love. We may smile. We are certainly surprised at the foolishness of a woman who failed to return his affections, but those of us who still remember our youth will understand how, for a time, for Edward Jenner no sun shone in the sky. "Still the same dead weight hangs upon my heart"; he wrote to his sympathetic friend Gardner, "would to God it would drag it from its unhappy mansion," and later, when the clouds were lifting, ever so little, "As for myself, the same stream of unhappiness is still flowing in upon me, its source seems inexhaustible, but there is a soothing consolation in it; all little disquietudes are sunk or washed away. I feel their influence no more."

Hunter, too, was sympathetic, for he knew Jenner, but he wrote with the sagacity that only the years can teach: "I can easily conceive how you must feel, for you have two passions to cope with, viz. that of being disappointed in love, and that of being defeated; but both will wear out, perhaps the first soonest."

And in time they did. The final cure was the ancient one of *similes similibus curantur,* like cures like. He fell in love again, and this time the affection was to last for life.

In the cold winter of 1786 he had ridden over to Kingscote to attend a patient. Who the patient was he does not see fit to mention, nor does he tell how long he was delayed there by the snowstorm that so nearly froze him to death. But we know that Catherine Kingscote had delicate health, and we know that he married her on March 6th, 1788, two years later. It is tempting to connect the events together into a romance.

It was indeed an idyllic marriage. Baron writes of her that she was "elegant in her manners, accomplished in her mind, and possessed an understanding of great vigour," and it is not difficult to believe that she was all this and a good deal more. A year after his marriage Jenner was writing to Gardner:

> "I can with truth assure you that the last year of my life, dating it from the month of March, has been the happiest beyond all comparison I ever experienced; and I will take upon me to aver (nay, I would swear it) that if you could be lucky enough to connect yourself with a woman of such a disposition as kind fortune has at last given to me, you will find a vast addition to your stock of happiness."

The letter was rather a long one, and Catherine evidently grew impatient, for he concludes:

> "Mrs. Jenner jogs my elbow to say she wishes to hear a duet."

It was only a week after his marriage that his paper entitled 'Observations on the Natural History of the Cuckoo' was read at a meeting of the Royal Society. He had been collecting information on the subject for many springs, and when his young nephew Henry became his apprentice he found himself not only helping with the patients, but also scouring the country round to see what the young cuckoos and their foster parents had been up to overnight. His aunt Deborah's farm at Clapton was an ideal situation for what we now call 'Bird watching', and in his bachelor days Jenner spent many weeks there exploring the woods and hedges. A few extracts from his notebook, now in the possession of the Royal College of Physicians, will serve to give an idea of the way he continued his enquiries:

> "May 5th (1787) Noted that the same cuckoo sung in different keys.
>
> 4th June the stomach of one (male cuckoo) contain'd 170 smooth caterpillars and a few small beetles.
>
> June 17th Saw a hedge sparrow's nest at Mr. Bromidge's, with two hedge sparrows in it hatched, two eggs not hatched and a cuckoo just hatched.
>
> 18th. In the morning early there were four hedge sparrows and the young cuckoo in it. Abt. noon it contained the cuckoo and one sparrow only and at night the cuckoo was left alone in the nest.
>
> July 9 The hedge sparrow in Cornock's orchard has hatched her two eggs (she sat on no more of her own) and the cuckoo's egg this morning. Fastened a piece of lead on the cuckoo's legs in such a way that he cant throw out his fellow nestlings."

The particular problem that was vexing him was that of how the eggs or fledglings of the owner of the nest were ejected to give sole possession to the usurping cuckoo. It is one of nature's horror stories, and the villain of the piece is neither the parent cuckoo nor the much abused foster parents, but the newly-hatched cuckoo itself. It is a shocking story; the Royal Society refused to believe it, and for nearly a hundred years most naturalists agreed with the Royal Society. Then the cine-camera was invented, and Jenner's facts were confirmed by a succession of photographs. For facts they were, not speculations. He had not only watched the nests in which cuckoos had laid their eggs but he had also devised experiments to prove that, when the activities of the young cuckoo were sufficiently restricted, neither eggs nor fledglings were thrown out of the nest. He had also noticed a peculiar depression in the young cuckoo's back on which it could balance either an egg or a fledgling, and so, heaving itself backwards towards the edge of the nest, as young birds do to eject their fæces, thrust it out. He had observed that at the end of about twelve days this depression filled up, and the instinct to eject the other inhabitants of the nest was lost. If the rightful occupants could survive for a fortnight they all became a happy family.

It must have been very irritating to Jenner to have the facts he had so carefully collected rejected. It can only be hoped that his bride was able to console him.

They were now settled at 'The Chantry', a house close to Berkeley church. After a year Edward Jenner the younger was born, then Catherine, and finally Robert, 'just a chip of the old block' as his father described him. Henry still lived with them and helped with the practice, and in time there was a governess and a tutor. Catherine kept a dormouse, about which her father wrote a poem, and there were probably other creatures, both wild and tame. The tom-tit that came to Catherine for tit-bits every morning inspired another poem. And there must have been visitors galore.

In the bustling but peaceful atmosphere of the home life of which he was the soul and centre Jenner carried on his medical work, but his active mind did not neglect the problem on which he had been engaged for many years. Stated briefly it was: did an attack of cowpox prevent an attack of smallpox, and was it possible to give protection against smallpox by an artificially induced attack of cowpox? If it were, then the scourge of smallpox could be conquered. It was a dazzling hope, scarcely to be expressed.

He first brought himself to speak of it to Edward Gardner. On a day in May in the year 1780 they were riding together from Gloucester to Bristol. It was Jenner's thirty-first birthday that month and he had been in practice about eight years. Emboldened perhaps by the hopefulness of the spring day he explained to his friend that he thought it might be possible to inoculate one cowpox patient from another, and so produce a resistance to smallpox so widespread that it would die out for lack of victims. But the facts were by no means proved, the critical experiment had not yet been tried, and Gardner was asked to keep his counsel.

Jenner's first task had been to collect all the available information about cowpox. Almost any rash contracted by milkers went by that name, but many such rashes had no effect whatever on susceptibility to smallpox. It was necessary to differentiate what Jenner called 'true cowpox' from other rashes, and then ascertain whether those who had had true cowpox had subsequently been exposed to infection from smallpox, either by natural contagion, or artificially by inoculation, and if so whether they had contracted it.

Cowpox, a countryman's rather than a townsman's disease, was not always prevalent in Gloucestershire. An epidemic would occur and give him the opportunity of examining several cases, and then it would die out, and his investigations would come to a halt. But as facts accumulated hope grew. Of this period he wrote:

> "While the vaccine discovery was progressive the joy I felt at the prospect before me of being the instrument destined to take away from the world one of its greatest calamities, blended with the fond hope of enjoying independence and domestic peace and happiness, was often so excessive that, in pursuing my favourite subject among the meadows I have sometimes found myself in a kind of reverie. It is pleasant to me to recollect that these reflections always ended in devout acknowledgements to that Being from whom this and all other mercies flow."

By the time his first baby, Edward, was a year and a half old he felt sufficiently confident to experiment by inoculating him with swinepox, a disease similar to cowpox. The child's mother was no doubt the more easily persuaded because inoculation with smallpox was the usual and more dangerous alternative. The inoculation produced in the child a mild pustular disease, and when at the age of about four he was again inoculated, this time with smallpox, no effect at all was produced.

It was not until May, 1796, that Jenner was able to perform the critical experiment for which he had been awaiting the opportunity. The story can be told in his own words, written at Berkeley in July of that year, to his earlier confidant Gardner:

> "As I promised to let you know how I proceeded in my inquiry into the nature of that singular disease the Cow-Pox, and being fully satisfied how much you feel interested in its success, you will be gratified in hearing that I have at length accomplished what I have been so long waiting for, the passing of the Vaccine Virus from one human being to another by the ordinary mode of inoculation. A boy of the name of Phipps was inoculated in the arm from a pustule on the hand of a young woman who was infected by her master's cows. Having never seen the disease but in its casual way before; that is, when communicated from the cow to the hand of the milker, I was astonished at the close resemblance of the pustules, in some of their stages, to the variolus pustules. But now listen to the most delightful part of my story. The boy has since been inoculated for the small-pox which, as I ventured to predict, produced no effect. I shall now pursue my experiments with redoubled ardour."

The name of the young woman who played such an important part in history was Sarah Nelmes, and a reproduction of Jenner's drawing of her hand and wrist is still included in many medical textbooks. It is a hand that, like the song of Browning's Pippa, has brought well-being into the lives of thousands of people the simple milkmaid never even dreamed of.

Jenner was now convinced that inoculation with cowpox was as effective a preventive as inoculation with smallpox. It was time to make his discovery public so that research might be carried on over a wider field, and the benefits of inoculation with cowpox might become more widely known. Jenner himself had already had a vision of a world free from the scourge of smallpox, but none realised better than he that the process must be carried forward step by step.

In June, 1798, he published a modest treatise to which he gave the title *An Inquiry into the Causes and Effects of the Variolae Vaccinae, a Disease Discovered in Some of the Western Counties of England. Particularly Gloucestershire and Known by the Name of Cow-Pox.*

It was an epoch-making document and he was well aware of it, but he indulged in no fanfares or superlatives, remarking simply in his dedication to Doctor Parry that he conceived "that the facts might appear at once both curious and useful."

The 'curious and useful facts' consist of accounts of twenty-three cases illustrating the three stages of his investigations. First he shows that an attack of cowpox, contracted in the usual way from cows, affords protection against smallpox; next that inoculation with cowpox performed with matter taken from a pustule, either on a cow or on a human being that had contracted the disease naturally, produces a mild pustular disease that neutralises the effects of inoculation with smallpox; and finally that inoculations with cowpox can be performed from one patient to another, the matter so transferred losing none of its characteristics, and the cowpox so communicated affording the same protection as when contracted directly from the cow.

Case II illustrates the first stage:

> "Sarah Portlock, of this place, was infected with the Cow-Pox, when a servant at a Farmer's in the neighbourhood,

> twenty-seven years ago. In the year 1792, conceiving herself, from this circumstance, secure from the infection of the Small-Pox, she nursed one of her own children who had accidentally caught the disease, but no indisposition ensued. During the time she remained in the infected room, variolus matter was inserted into both her arms, but without any further effect than in the preceding case."

Sarah Nelmes, the dairymaid, is case XVI, and since she provided material for the first example of vaccination her case may be quoted in full:

> "Sarah Nelmes, a dairymaid at a Farmer's near this place, was infected with the Cow-Pox from her master's cows in May 1796. She received the infection on a part of the hand which had been previously in a slight degree injured by a scratch from a thorn. A large pustulus sore and the usual symptoms accompanying the disease were produced in consequence. The pustule was so expressive of the true character of Cow-Pox as it commonly appears upon the hand that I have given a representation of it in the annexed plate."

After Sarah Nelmes comes the first case of vaccination, that of James Phipps:

> "The more accurately to observe the progress of the infection, I selected a healthy boy, about eight years old, for the purpose of inoculation for the Cow Pox. The matter was taken from a sore on the hand of the dairy maid who was infected by her master's cows, and it was inserted, on the 14th of May, 1796, into the arm of the boy by means of two superficial incisions, barely penetrating the cutis, each about half an inch long.
>
> On the seventh day he complained of uneasiness in the

> axilla, and on the ninth he became a little chilly, lost his appetite and had a slight head-ache. During the whole of this day he was perceptibly indisposed, and spent the night with some degree of restlessness, but on the day following he was perfectly well.
>
> In order to ascertain whether the boy, after feeling so slight an affection of the system from the Cow Pox virus, was secure from the contagion of the Small Pox he was inoculated the 1st of July following with variolus matter immediately taken from a pustule. Several slight punctures and incisions were made on both his arms, and the matter was carefully inserted, but no disease followed.... Several months afterwards he was again inoculated with variolus matter, but no sensible effect was produced on the constitution."

Cases XIX to XXIII take the experiment to its final stage. William Summers, a child of five, was inoculated with matter taken from a cow, Hannah Excell was inoculated with matter taken from William Summers, four children were inoculated with matter taken from Hannah Excell (one of these was Jenner's eleven-months-old child Robert, in whom, however, it did not 'take'), and with matter taken from one of these children yet another was inoculated.

At last Jenner, satisfied with his results, writes: "it did not appear necessary, nor was it convenient to me, to inoculate the whole of those who had been subjects of these late trials." Nevertheless two of them were handed over to his nephew Henry for inoculation, and, as a test, another patient who had not had the cowpox was inoculated with the same variolus matter, and had "Small-Pox in the usual regular manner."

In summing up his findings Jenner asserts confidently, "Cow Pox protects the human constitution from the infection of Small Pox." He did not claim that inoculation with cowpox produced an absolute immunity. "Duly and efficiently performed," he states, "it will protect the constitution from subsequent attacks of Small Pox, as much as that disease itself will. I never expected that it would do more, and it will not, I believe, do less."

The publication of the *Inquiry* meant a sudden blaze of publicity for Jenner. Modest and moderate though it was, it aroused heated and often bitter controversy. Some of the 'inoculators', seeing their credit threatened, opposed it, others accepted it with uncritical enthusiasm and themselves began inoculating with cowpox. (For the London inoculators cows were available in the fields of Mary-le-Bone and Gray's Inn.) But they failed to observe Jenner's careful technique. Sterilisation of instruments was as yet unheard of, and there was even a case where a lancet was used for inoculation with cowpox that had previously been used, and not afterwards cleaned, for inoculation with smallpox. The very advocates of the system were bringing it into disrepute.

Jenner realised that his methods must be more widely demonstrated. He set out in his carriage on the three days' journey to London "over roads I should suppose as bad as ever coachman of Julius Cæsar drove over," he wrote. But nobody in London wished to be inoculated by him. For those who cared to risk it there was already inoculation with smallpox; inoculation with cowpox might produce horns and a tail, who could tell? So Jenner, tired of inaction and homesick for the country, went back again to Gloucestershire. Before he left he gave some of his cowpox vaccine to his friend Henry Cline, a surgeon at St. Thomas's Hospital. One day Cline used it, not for the purpose intended, but as a counter-irritant in a case of hip-joint disease. Later on, he had occasion to inoculate the same patient with smallpox, but the operation had no effect. Evidently the vaccine, as a protection against inoculation with smallpox, was all Jenner had claimed for it. He demonstrated its effects to his colleagues, among them a Dr. Lister, who had been physician to the smallpox hospital in London and was an authority on the disease.

Gradually the credit of Jenner's methods grew. In these early stages inoculations were performed from one person to another, and required a constant chain of patients. An expedition which sailed from Cadiz in 1803 to "spread the practice of vaccination to the possessions of the King of Spain beyond the seas" carried twenty-six children, each to be inoculated in turn, and so maintain a fresh supply of vaccine during the voyage. It was inconvenient, and there was a danger, of which, however, Jenner's contemporaries were not acutely aware, of communicating diseases other than cowpox, and more sinister. But in the course of time manufacturing chemists —to whom a greater debt is owed than is always recognised— overcame the difficulties. Lymph now supplied for vaccination is obtained from carefully selected and inoculated calves, and is preserved in sterile glycerine, a method invented by Robert Koch some fifty years later.

The cumbrous phrase 'inoculation with cowpox' was soon replaced by the appropriate word 'vaccination', the invention of which Jenner attributes to his friend R. Dunning, Esq., a surgeon of Plymouth.

Between August, 1799, and February, 1800, Jenner vaccinated 1,500 people. His friends urged him to set up in practice in London, where they were convinced he would make his fortune. His chief concern was that vaccination should not be discredited by carelessness and ignorance on the part of the operators, and it was duty rather than ambition that induced him to go back again to London. He took a house in Hertford Street, Mayfair, and waited for patients. But in London he was not loved and trusted as he was in Gloucestershire. In time he might have made his fortune, but meanwhile patients were few and expenses high. If London did not want him neither did he want London. The noises were different then from what they are now, but noisy it was from before dawn until dusk, and it stank of worse than petrol fumes.

> "I have done with it" he wrote "and have again commenced village-doctor. I found my purse not equal to

> the sinking of a thousand pounds annually, (which has actually been the case for several successive years,) nor the gratitude of the public deserving such a sacrifice."

For some years his nephew Henry had been able, when necessary, to carry on the practice at the Chantry alone, and Jenner had spent much of the summer at Cheltenham. He now divided his time between Cheltenham and Berkeley, with occasional less welcome interruptions to the life he loved, of visits to London. He wrote of fame much as Sydenham had done:

> "And as for fame, what is it? a gilded butt, for ever pierced with the arrows of malignancy. . . . Shall I, who even in the morning of my days sought the lowly and sequestered paths of life, the valley, and not the mountain; shall I, now my evening is fast approaching, hold myself up as an object for fortune and for fame? Admitting it as a certainty that I obtain both what should I add to my little fund of happiness?"

But he could not altogether avoid publicity. He wrote of it to his friend Doctor Worthington:

> "I am by accident, you know, become a public character; and having the worst head for arrangement that ever was placed on a man's shoulders I really think myself the most unfit for it. You may form some judgment of my accumulated vexations when I tell you, that I am at this moment more than a hundred letters behindhand with my correspondents. I have been lately deprived of the aid of my secretary. He was cut off by the same dreadful disease, which, I fear, will shortly take from me my son."

The secretary was the brilliant tuberculous boy, John Worgan, whom, at the age of sixteen, Jenner had taken into his household as tutor to his son, ignorant of the danger he was bringing to his family. Worgan had helped him with the world-wide correspondence that must now be attended to. For although the popularity of vaccination increased very slowly in England, abroad it was spreading with astonishing rapidity, and his advice was constantly sought.

Nor was he satisfied with his earlier experiments, which he had always regarded rather as a beginning than as an end. He continued his investigations, and in 1799 followed up the publication of the *Inquiry* with that of *Further Observations*, and in 1800 with yet another booklet, in which he met and explained some of the objections of his opponents.

And the old life went on, busier than ever now, The Barrow Hill Club met at the 'Bell Inn' at Frampton; there were bread and cheese dinners under the fossil rock; he collected observations on the migrations of birds. Nor had he forgotten how to sing:

> "I have seen him," wrote Baron, "in his latter years after his renown had filled the world, and after the many cares attendant upon vaccination had often weighed heavy upon him, shake them entirely off, he would then take up a humorous strain, and sing one of his own ballads with all the mirth and gaiety of his youthful days."

He had not given up writing verses. The humour is heavy by modern standards, for life, in spite of vast accomplishment, was leisurely, and it was not necessary to fit in a joke between two bites of a sandwich. *The Dialogue between Death and Mr. Peach* will serve as an example of his style:

Peach Awhile forbear thy horrid gripe.
Do pray, dread Sir, remember
Peaches are never fairly ripe
'Till August or September.

Death To gratify my longing taste
And make thy flavour fine
I had thee in a hot-house placed
And moistened well with wine.

and on the death of a notorious miser he wrote:

"Tom at last has laid by his old niggardly forms
And now gives good dinners, to whom pray? the worms."

He wrote a number of nature poems, among them two to the robin. One of these, though little more than doggerel in its expression shows a realistic point of view modern enough to merit quotation. He could sentimentalise as well as any Christmas card, as the other robin poem shows, but he had no illusions:

"Have I not seen thee, sturdy ruffian,
With impious claw thy father cuffing?
Seen thee, thou vile imposter, blackguard,
With many a blow thy mother smack hard?
Strip from her back the downy feather,
Spite of inclemency of weather:
Nay, threaten her with instant killing,
If thy full platter she put bill in."

He was, on occasion, capable of combining accurate observation with genuine poetic feeling, and any account of his verse writing would do him a grave injustice that did not include one such example. An extract from a poem on 'The Signs of Rain' will serve:

"The hollow winds begin to blow,
The clouds look black, the glass is low,
The soot falls down, the spaniels sleep,
And spiders from their cobwebs creep.

Last night the sun went pale to bed,
The moon in halos hid her head,
The boding shepherd heaves a sigh,
For see! a rainbow spans the sky.
The walls are damp, the ditches smell,
Clos'd is the pink-eyed pimpernel. . . ."

It is perhaps not great poetry, but it is the music of the English countryside, and it shows the mind of a man who looked with a clear eye at the things he loved.

Retired though he was in the country, gradually recognition came to him. He had already, in 1792, become a Doctor of Physick of St. Andrews University. Oxford conferred on him an Honorary M.D. in 1813—unfortunately on the occasion of his receiving it he could not be altogether cheerful because Robert had returned from school with a cough.

Parliament made him a grant of £10,000 in 1802, so confirming beyond dispute the value to the country of vaccination. Five years later they made him a second grant, this time of £20,000. In these days of niggardly recognition of the doctor's service to the community it seems a large sum, but his friends thought it miserably inadequate. Jenner himself admitted that it was no more than he had lost by devoting himself to the cause of vaccination rather than to his practice, and it is certainly nothing to what he would have made had he kept it as a secret preventive against smallpox, which he might well have done without doing great violence to contemporary ethics.

In 1800 he was presented to the King, to whom he had dedicated the second edition of the *Inquiry*, and he had a private interview with the Prince of Wales. It was gratifying, and he seems to have found it amusing too. "What will you give," he wrote to his friend Mr. Shrapnell, "for a sight of me all in velvet, girt with a sword too? What a queer creature is a human being?"

But along with the satisfaction of public recognition came the sorrow of personal loss. 'The dear man' had died in 1793, before Jenner's researches into cowpox, in which he had expressed a lively interest, had become significant. He was already famous when death darkened his own household. John Worgan died in 1809, his son Edward a year later, at the age of twenty-one, of the same disease. His feelings were too deep to be easily overcome.

> "One would suppose," he wrote, "that the mind would become in some measure reconciled to an event, however melancholy in its nature, that one knows to be inevitable, when it has made such gradual approaches; but I know, from sad experience, that the edge of sensibility is not thus to be blunted."

Mrs. Jenner had never been robust, and for years he had watched over her with the tenderest care. When she died in 1815 he was almost inconsolable. His friends tried to tempt him away from the scene of his loss, but he wrote:

> "Every surrounding object the more forcibly reminds me of my irreparable loss. Every tree, shrub, flower, seems to speak. But yet no place on earth would at present suit me but this."

Of bitterness he was incapable, but he felt his loneliness. He wrote to Baron:

> "Pray don't desert this forlorn cottage, but come sometimes, and chase away my melancholy hours."

He had no need to invite, for to the very end his welcome and his company were sought by old and young, rich and poor. He had the gift of uniting active benevolence to the world at large with kindness and charm for those around him, expressed in perfect manners and perfect sincerity.

His last days were comforted by the knowledge that the practice of vaccination was spreading over the whole civilised, and much of the uncivilised, world. In London the Royal Jennerian Society gave place to the National Vaccine Establishment, and although inoculation with smallpox did not entirely die out until abolished by law in 1840, its popularity steadily declined and vaccination took its place. Jenner knew that he had been the means of saving more lives than the activities of Napoleon, across the Channel, had been the means of destroying.

On the day before he died he walked into the studio of his nephew Stephen, who, whilst he worked at his easel, was singing a Scotch air.

"Oh! you are singing," remarked Jenner, "but not in the right way, let me tell you. This is the manner in which you ought to do it." And, seventy-three years old though he was, he sang the air for him correctly.

To the very end his professional life continued, and on that same evening he visited one of his patients, and on his return made notes of his symptoms. But he was beginning to feel his years. Three years previously he had had a serious seizure. The next morning, the 26th of January, 1823, he had a second, and in a few hours it was fatal.

He was buried in his beloved Berkeley, but his statue is in Kensington Gardens, where it watches benignly over the play of children from whose lives he lifted the shadow of smallpox, which, but for him, would have carried off some seven of every hundred who play there.

CHAPTER NINE

Surgical Interlude

1. Barbers and Surgeons

"*. . . . it was the custom to give the patient a long stick to hold, which he grasped hard, working his fingers up and down it to make the veins of his arms stand out . . . the barber's pole is the descendant of the bleeding stick. As for the bright stripes painted spirally round it, they are the coloured tapes that were bound as ligatures round the arm above the elbow.*"

(from the Middlesex Hospital Journal, 1903)

Up to this point the words doctor, physician, apothecary, and surgeon have been used with little attempt at precision. Mediæval terms, like mediæval spelling, were allowed a latitude not permissible since science and compulsory education have broadcast their blessings. The underlying intention, however, has been to suggest by the words doctor or physician the prototype of the general practitioner, and by the word apothecary the prototype of the druggist. The picture is more nearly accurate if we bear in mind the fact that the doctor was at the undisputed head of the profession; that the specialist, except in the form of a charlatan, did not exist; and that as late as the eighteenth century the apothecary, besides supplying drugs, acted as an inferior and cheaper kind of physician.

The term surgeon cannot be so briefly explained, for it is bound up with the vicissitudes of the profession, and if medicine may be said to have had its ups and downs surgery may be said to have had its downs and ups. Until the discovery of antiseptics and anæsthetics its field was very restricted. In war the surgeons' craft was in urgent demand and amputations were only too numerous, but in peace it was limited to cases of accident; to minor operations such as bleeding, lancing, tooth-drawing; and to occasional desperate remedies such as operations for hernia, the stone, or cataract.

Many of these were performed by itinerant operators, skilled in the performance of one operation only, the 'mystery' of which was handed down from father to son. Bleeding and tooth-drawing were the province of the barbers or, as they came to be called, barber-surgeons.

The association of barbers and surgeons has indeed been over-emphasised, and there is a tendency to overlook that of surgeons and physicians. In the fourteenth century John of Mirfield, a clerk of the Priory of St. Bartholomew, Smithfield, wrote in the *Breviarium Bartholomei*:

> "Long ago, unless I mistake, physicians used to practise surgery, but nowadays there is a great distinction between surgery and medicine, and this, I fear, arises from pride, because physicians disdain to work with their hands, though, indeed, I myself have a suspicion that it is because they do not know how to perform particular operations, and this unfortunate usage has led the public to believe that a man cannot know both subjects, but the well informed are aware that he cannot be a good physician who neglects every part of surgery, and on the other hand, a surgeon is good for nothing who is without knowledge of medicine."

The Hippocratic Corpus confirms his surmise that there had been physicians who practised surgery, but it also makes it clear that there had been a school of physicians who did not. It has already been noticed that religious motives, both with Arabs and Christians, left surgical remedies in the hands of inferiors, but when the great school of Salerno flourished medicine and surgery were taught side by side, and Theodoric of Bologna (1205-1295) is an example of a Churchman who was also a noted surgeon. With the development of the Universities the relationship between the two professions changed again. Medicine became a learned profession, to be learnt in the lecture room and from ancient literature, surgery became a craft, to be learnt as other crafts were learnt by the practical experience of apprenticeship. The physician took the title of 'Magister' on the completion of his studies, and could be addressed as 'Master Doctor', a dignity to which the surgeon could lay no claim.

But there were certain exceptions. The College of St. Cosimus at Paris, founded for the care and protection of its members, developed into a teaching and licensing body, and surgeons licensed by the college were entitled to wear the 'long gown' of the scholar, and to use the title 'Master'. There are also two early records at Oxford of Magister Rogerus, Cirurgicus, and of Magister Petrus, the King's surgeon, but it is possible that the degrees were granted in some subject other than surgery, for the distinction between the art of medicine and the craft of surgery was firmly established in the University of Oxford.

The association of barbery and surgery, emphasised by their alliance in the craft guilds, probably originated in opportunism and the barber's skill in the use of sharp instruments. The barber-surgeon, a man of many parts, was a familiar figure in the villages and townships of mediæval Europe. He was frequently the only available 'medical man', and must often have shared the oversight of the health of the countryfolk with the local wise woman. Like other craftsmen he learnt his trade as an apprentice, and probably, in common with other manual workers who begin to learn their craft early in life, achieved a high degree of manual dexterity.

In warfare, where the number of army surgeons was generally inadequate, his experience extended beyond mere bleeding and tooth-drawing, and he must be as ready to amputate a limb as to trim a beard. He had every opportunity of becoming a skilful surgeon according to the standard of the times, and the distinction between surgeon and barber-surgeon was apt to lose its meaning.

Ambroise Paré (*c.* 1510-1590), one of the greatest surgeons of all time and surgeon to four successive kings, started his career as apprentice to a barber-surgeon. Subsequently he worked for three years in the Hôtel Dieu in Paris, and was then considered sufficiently well qualified for the post of Regimental Surgeon to Marshal Montejan in the army of Francis the First. But Ambroise Paré was not only a genius but also a man of such endearing qualities that he was able to do many things that genius alone could not have accomplished. Whilst the cantankerous Paracelsus wandered through Switzerland and Germany, unloved and almost unhonoured, Paré was fêted by courtiers and kings. He introduced without opposition methods contrary to the teaching of Galen; he was entreated by the scholars to recount his experiences in writing, and, knowing no Latin, did so in the language of the people. Although he was not a Catholic and was in Paris on the night of the massacre of St. Bartholomew, he was not murdered; and, perhaps most extraordinary of all, he became in 1654 a Master-Surgeon and teacher at the College of St. Côme. Two of his sayings have echoed down the centuries: "You will have to render account not to the ancients but to God for your humanity and your skill" is one of them, and another, "I dressed him and God healed him." The vicissitudes of language have substituted 'Nature' for 'God', but the meaning remains the same.

When the craft guilds first came into existence barbers and surgeons were generally included in one guild. The surgeons were not eager to associate with the barbers, and tried to maintain a superior position, but nevertheless guilds of barbers "exercising the mystery or art of surgery" were numerous. Membership of a guild was first customary, and then compulsory, and as guilds were local affairs surgeons and barbers had to join with other arts and crafts as well as with each other if no guild of their own was available. In Florence one such guild included thirty-six different trades, amongst them mercers, artists, poets, barbers, physicians, chandlers, waferers, and rope-makers. Of this guild Dante was a member.

A guild of surgeons existed in London at a very early date, and its story is typical of the varying relationship between barbers, surgeons, and physicians. Probably in its earliest days the guild included surgeons only, but when it was recognised by the city in 1308 it already included barbers. The two crafts, however, were distinct, and the surgeons tried to insist on their superiority, but not always with success. There are records that in 1376 the company had two 'Masters', one representing the barbers, the other the surgeons. Then, in 1423, the surgeons separated themselves from the barbers, allied themselves to their learned brethren the physicians, and a joint college of Physicians and Surgeons was formed under the patronage of the Mayor and Aldermen of London. It was an uneasy partnership. It caused annoyance to the barbers, who were left outside the pale, without pleasing the physicians, firmly entrenched within it. It held together only for a few years, and in 1435 an independent guild of surgeons was formed which included neither physicians nor barbers. The barbers then became active on their own behalf, and in 1462 obtained a charter from Edward the Fourth for "the free men of the mystery of Barbers of our city of London exercising the mystery or art of surgery." This charter made provision for education in the craft by apprenticeship and by lectures in surgery and anatomy. The barbers had stolen a march on the surgeons, who had disdained them to flirt with the physicians. The position of the surgeons became still worse when the College of Physicians was founded in 1518, leaving them out. The physicians would have none of them. If they were to maintain, or even obtain, their privileges they must associate, whether they liked it or not, with the barbers.

And so it came about that in July, 1540, the Parliament at Westminster passed an Act of Incorporation, and Henry the Eighth presented the charter of the Livery Company of the Barber-Surgeons to his Sergeant Surgeon Thomas Vicary in the presence of the assembled Royal Barbers and Royal Surgeons. For legal purposes they were now united, but the charter recognised a distinction between them. Surgeons in future were not to act as barbers, and the Company was to have four Masters, two of them to represent the surgeons and two the barbers. Educational facilities were to be provided, apprentices were to be able to read and write, and the bodies of four executed criminals were to be provided annually for the study of anatomy. A later regulation insisted on proficiency in Latin.

The surgeons had lost nothing by association with the barbers, and the granting of the charter was without question a great occasion, which Holbein was called in to record. His picture still hangs in the Royal College of Surgeons in Lincoln's Inn Fields. It depicts two of the Royal Physicians, Doctors Chambre and Butts; Thomas Alsop, the Royal Apothecary; three Royal Surgeons and three Royal Barbers, the chief of whom numbered among his duties that of attending at the palace every Saturday night, "if it please the King to cleanse his head, legs or feet." Another clause required that members of the Company should attire themselves on feast days and certain other occasions in full livery, a gown made of four yards of the best broadcloth, striped athwart.

With so much of honour the surgeons had to be content. It was over a hundred years before they made any further attempt to separate from the barbers and yet another hundred before their efforts were successful. At last, in 1745, a Bill was passed by Parliament dividing the surgeons and barbers of London into two distinct corporations and authorising the formation of a Company of Surgeons under the name of the "Masters, Governors and Commonalty of the Art and Science of Surgeons of London."

Honour, however, had to be its own reward, for the barbers could not be persuaded to part with any of their assets, and although the new poor managed to build a surgeons' hall, with library and lecture theatre, they could not command the means to keep them in repair. In the eighteenth century the most famous school of surgery in London was the private one owned by William Hunter, John Hunter's eldest brother, and carried on in his own house, which is now part of the Lyric Theatre in Shaftesbury Avenue. It was not until the year 1800 that the College of Surgeons obtained a Royal Charter, and even when it became in 1843 the Royal College of Surgeons of England its influence was limited; licensing was not always enforced, and country districts were the prey of quacks and charlatans until the Medical Registration Act of 1858. Even this could not put an end to their activities, but it at least enabled the public to differentiate between the trained man and the adventurer.

Although until the nineteenth century surgery was generally regarded as an unlearned profession there were, nevertheless, great surgeons who learnt their craft in the anatomy schools, in hospitals, and as apprentices, and attained a degree of skill amazing even by modern standards. There was William Cheselden (1688-1752), who could perform a lithotomy in fifty-four seconds; Percival Pott, who gave his name to a fracture, not, however, as is often supposed, the fracture of the tibia that he sustained himself, when he fell from his horse and was carried home on a door, issuing voluble directions as to his treatment; there was Robert Liston, who could amputate a thigh in twenty-five seconds with only one assistant; Spencer Wells, who designed the forceps that bears his name, and the Lancashire surgeon, Hugh Owen Thomas, son of a bonesetter, who invented the Thomas's splint, still in constant use. The list could be extended to many pages, but these few names, taken at random from those of a single country, may serve to remind us that there were great surgeons before the days of anæsthetics and antiseptics, and that they were all the greater for the difficulties in which they worked.

2. THE DISCOVERY OF ANÆSTHETICS

"Give me to drink mandragora. . . .
That I might sleep out this great gap of time
My Antony is away."
(ANTONY AND CLEOPATRA)

UNTIL the middle of the nineteenth century lack of anæsthetics set an obvious limit to what the surgeon could do. At all costs he must minimise the sufferings of the patient, who was tied and held down, his twitching muscles tense with fear. Speed was everything. Delicate operations that might have conserved a limb had to give place to straightforward amputations; abdominal operations were rare and generally fatal. The full implications of operating without anæsthetics will hardly bear thinking of. Professor George Wilson, in a letter to Sir James Young Simpson, described his feelings whilst his foot was being amputated at the ankle joint by Professor Syme of Edinburgh, the father-in-law of Lister, and one of the most skilful surgeons of his time.

> "Of the agony it occasioned I will say nothing. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten, but the black whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering close on despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so."

It was a gruesome business. No wonder that the Senior Surgeon to the Gloucester General Infirmary, Charles Brandon Trye, never "performed an operation without retiring to meditate and pray, and seek for guidance and assistance."

From ancient times there had existed a belief in preparations to induce forgetfulness. Zeus-born Helen, according to Homer, possessed a variety of drugs, "antidote to the pains of grief and anger." Aesculapius was credited with the use of a nepenthe. The Romans used a soporific sponge soaked in opium and henbane; the hashish of Egypt and Arabia, which was prepared from Indian hemp, served a similar purpose, and Dioscorides recommended mandragora wine for insomnia and the pain of operations. All these are mentioned in the early herbals. Mandragora was a great favourite in literature, but less, perhaps, for its intrinsic qualities than for its sonority in the poetic line. When Iago gloats:

> "Not poppy nor mandragora
> Nor all the drowsy syrups of the world
> Shall ever medicine thee to that sweet sleep
> Which thou owedst yesterday."

he was strictly accurate, for no known drug could guarantee sleep to the sleepless, much less bring unconsciousness to those in pain. But if we discredit the complete efficacy of the drowsy syrups, and ignore such potions as were swallowed with merited distrust by the Juliets and Imogens of romance, we may still accept the fact that there were soporific drugs that had an effect something less than magical and far short of anæsthetic. Sweet vitriol, discovered by the Majorcan mystic Raymón Lull, was more effective than these. It was used by Paracelsus, who distilled sulphuric acid mixed with alcohol, a process that gave off a certain amount of ether, and must have been the best narcotic then known. Alcohol was used by surgeons in the army and navy in the eighteenth and nineteenth centuries, or more specifically by the friends of the patient, who made him drunk, so that he could face his operation more philosophically.

None of these attempts at anæsthesia was significant except as an expression of its desirability. Poets and druggists might believe that somewhere in nature was hidden a herb of forgetfulness, if only it could be found, but it was the prosaic work of the chemists on the isolation of gases that led to its discovery, and it was not a herb but a gas. When Joseph Priestley in 1772 isolated nitrous oxide he had opened the way to a hitherto undreamed-of method of producing 'forgetfulness.'

Nitrous oxide was the so-called 'laughing gas' with which Sir Humphrey Davy experimented on himself at the age of seventeen. Two years later, in 1800, he published the result of his researches in a book called *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide.* He described how he had used it to alleviate the pain of cutting a wisdom tooth, and even suggested that it might be used with advantage during surgical operations.

But the surgeons did not take the matter up. Nor did Michael Faraday's article catch their attention in 1818, when he wrote on '*The Effects of Inhaling the Vapour of Sulphuric Ether*'. This was the sweet vitriol used by Paracelsus, now named ether by the German chemist Frobenius, and included in the early nineteeth-century pharmacopœias. In 1831 chloroform was discovered. Here at last were some real 'nepenthes', but the only medical man who showed any interest in them as such was a young country doctor, Henry Hickman (1800-1830) of Shifnal, a small market town not far from the Wrekin; and nobody of importance took any notice of Hickman until he had been dead for over a hundred years.

And yet he foresaw the possibility of performing major operations without pain to the patient, and not only theorised but also experimented. His experiments were described in a letter on 'Suspended Animation', addressed to T. A. Knight, Esqr., of Downton Castle, Hereford, who was a member of the Royal Society, and the letter was published in 1824 by W. Smith, of Ironbridge. Hickman gave an account of six operations on puppies, mice and dogs, which had been performed successfully and apparently without pain. The insensibility had been induced in some instances by placing the creatures "under a glass cover, surrounded by water, so as to prevent the ingress of atmospheric air, where their respiration in a short time ceases." In other experiments the insensibility was "much more suddenly brought on by the agency of sulphuric acid and carbonate of lime." It is true that the carbon dioxide so produced would, in sufficient concentration, have asphyxiated the creatures, but the line of enquiry was significant, and would doubtless, had it been followed, have produced less questionable results. Dr. Hickman's paper continued:

> "As the recital of such experiments as those preceding must be as little agreeable to you, as the repetition of them has been to myself I shall not give a detail of any others, but shall only state the opinions which the aggregate results have led me to entertain. I feel perfectly satisfied that any surgical operation might be performed with quite as much safety upon a subject in an insensible state, as in a sensible state, and that a patient might be kept with perfect safety long enough in an insensible state for the performance of the most tedious operation . . . I feel so confident that animation in the human subject could be safely suspended by proper means, carefully employed, that (although I could not conscientiously recommend a patient to risk his life in the experiment) I certainly should not hesitate a moment to become the subject of it, if I were under the necessity of suffering any long or severe operation."

The letter was sent to the Royal Society and to the French Academy of Medicine, but it made no impression. Dr. Hickman was either too young or too obscure to attract attention to his research, and he was never called upon to play his willing part in the experiment that might have saved years of suffering. In 1830, at the age of thirty, he died.

It was not, then, in England, but in America, that anæsthetics were first used. The problem as to who it was that first discovered their use (leaving Dr. Hickman's abortive experiments out of account) takes a good deal of untangling. It is like a ball of wool after the games of a lively kitten, and when we come to unravel it we find that, like the wool, it has more ends than one. For there was more than one American who, quite independently, adopted the use of anæsthetics at about the same time.

Americans, for the most part, enjoy a carefree individualism that enables them to accomplish, without waiting for a lead from their seniors, what seems to them right and possible. They also possess an exuberant vitality that shows itself in a thirst for experience that does not necessarily wait on its evaluation. It was a combination of these qualities that led to the discovery of the use of anæsthetics.

Zest for experience for its own sake found an outlet in the apparent absurdities of 'laughing-gas parties' and 'ether frolics'. These were conducted by 'Professors' of chemistry, who travelled round the country giving lectures and demonstrating on members of the audience the entertaining effects produced by inhaling nitrous oxide or ether. It occurred to William E. Clarke, whilst taking part in one of these gaieties, that ether might be put to more practical use than to provide slap-stick comedy, and accordingly, in January, 1842, he tried its effect on Miss Hobbie, when her dentist, Dr. Elijah Pope, had occasion to extract one of her teeth. She found the operation, if not amusing, at least painless.

This event took place in Rochester, New York. Meanwhile, at the University of Pennsylvania, a young physician, Crawford W. Long, of Jefferson, Georgia, and his friend James M. Venable, had also become interested in the more practical application of ether frolics. Venable had a small tumour on his neck, which seemed to Long to offer an opportunity for experiment. He persuaded Venable to allow him to remove it whilst he was under the influence of ether, and Venable found that the operation was painless. Dr. Long continued to use ether for minor operations, and even in certain cases of childbirth, but he did not publish his results until 1849.

Five years before the publication of Dr. Long's paper Horace

Wells, in Hartford, Connecticut, one of the town's leading dentists, attended a demonstration of laughing gas given by Dr. Gardner Q. Colton. During the demonstration a member of the audience who was under the influence of the gas accidentally injured his leg, and Dr. Wells observed that he appeared quite unaware of the fact until the effect of the gas had worn off. He was the more interested since he himself was suffering from an aching tooth which was in urgent need of extraction. In the hope of mitigating the misery of the operation he persuaded Dr. Gardner to give him a dose of the gas the next morning, December 11th, 1844, whilst Dr. John M. Riggs pulled it out. He was so impressed by the painlessness of the dreaded operation that he persuaded Colton to show him how to prepare the gas, and he began to use it on his patients. Before long he gave a lecture and demonstration on the subject at Harvard Medical School. Unfortunately this was not a great success, for the patient was not sufficiently anæsthetised, and screamed. The students were not favourably impressed.

However, there was in the audience on this occasion one of his former pupils, William Morton, with whom he had since been in partnership. In spite of the only partial success of the demonstration Morton thought that gas had useful possibilities. He consulted Dr. Charles A. Jackson, who, besides being a medical practitioner, was a chemist of some note. Together they began experimenting with sulphuric ether. At first he used it only as a local anæsthetic, but on September 30th, 1846, he persuaded Mr. Eben H. Frost to inhale the gas, and when he had become unconscious he extracted an ulcerated tooth without causing him any pain. This success encouraged him to apply to Massachusetts General Hospital to be allowed to administer his preparation for surgical operations, and on October 16th, 1846, Dr. John C. Warren removed a tumour from the jaw of Gilbert Abbot, who had been rendered unconscious by inhaling a vapour from a special apparatus constructed for Morton by an instrument maker. The next day another surgeon, Dr. Hayward, made use of Morton's services whilst he removed a large fatty tumour from a patient's arm. Both hospital staff and patients were impressed with the results and Morton was engaged to administer his gas regularly for operations performed at the hospital. At first it was called 'Morton's gas' and he would not disclose the nature of the preparation he used, but medical ethics, in the shape of the surgeons of the hospital, were too strong for him. They recognised the gas without difficulty as ether, and in the same year one of them published a complete account of its use.

This was read by Oliver Wendell Holmes, who greeted it as the great discovery it undoubtedly was, and being, like many other notable physicians, also a man of letters, he hastened to give precise expression to the new process in words. In a congratulatory letter to Morton he wrote:

> "Everybody wants to have a hand in the great discovery. All I will do is to give you a hint or two as to names, or the name, to be applied to the state produced, and to the agent.
>
> The state should, I think, be called 'Anæsthesia'. This signifies insensibility, more particularly (as used by Linnaeus and Cullen) to objects of touch. The adjective will be 'Anæsthetic'. Thus we might say the 'state of anæsthesia', or the 'anæsthetic state'. The means employed would be properly called the 'Anti-æsthetic Agent. Perhaps it might be allowable to say 'Anæsthetic Agent', but this admits of question."

The question was resolved by convenience. Anti-æsthetic agent was too cumbersome for everyday use. 'Anæsthetic agent' appears in the writings of Sir James Young Simpson, and was evidently in occasional use. According to the Oxford English Dictionary the word anæsthetic came into the language as a substantive in 1848, and if Oliver Wendell Holmes did not have a whole hand in the nomenclature he had a good deal more than a finger.

The question of priority of discovery is of small moment compared with the immeasurable benefits the discovery has brought. The above facts have been taken from a recent *History of Surgical Anæsthesia*, by an American, Thomas E. Keys. Gratefully we hand the bouquet across the Atlantic, and leave it at that.

The first surgical operation performed in England under an anæsthetic was on December 21st, 1846. An account of it, written by an eye-witness, Dr. F. W. Cock, appeared in a supplement to the *American Journal of Surgical Anæsthesia*, of July, 1915. It is worth quoting not only for its bearing on anæsthesia but also for the picture it gives of pre-Listerian surgery at its best. Dr. Cock tells his story in dramatic fashion:

> "The hall of the theatre is now almost full; it is 2.15 p.m. A firm footstep is heard and Robert Liston enters—that magnificent figure of a man, six feet two inches in height, with a most commanding expression of countenance. He nods quietly to Squire, and, turning round to the packed crowd of onlookers, students, colleagues, old students, and many of the neighbouring practitioners, says dryly: 'We are going to try a Yankee dodge today, gentlemen, for making men insensible'.
>
> He then takes from a long, narrow case one of the straight amputating knives of his own invention. It is evidently a favourite instrument, for on the handle are little notches showing the number of times he had used it before. His house-surgeon, Ransome, puts the saw, two or three tenacula, and the artery forceps, named after the operator, on to the chair close by, and covers them with a towel, then threads a wisp of well-waxed hemp ligatures through his own buttonhole. 'Ready, Mr. Ransome?' 'Yes, Sir.' 'Then have him brought in' . . .
>
> The patient is carried in on the stretcher and laid on the table. The tube is put into his mouth, William

Squire holds it and the patient's nostrils. A couple of dressers stand by to hold the patient if necessary, but he never moves, and blows and gurgles away quite quietly. Liston stands by, trying the edge of his knife against his thumb-nail, and the tension increases; the patient's breathing gets deeper, more ether is dripped on the sponge. William Squire looks at Liston and says 'I think he'll do, sir.' The tube is removed and a handkerchief laid over the patient's face. 'Take the artery, Mr. Cadge,' cries Liston. Ransome, the house-surgeon, holds the limb. 'Now, Gentlemen, time me,' says Liston to the students. A score of watches are pulled out in reply. The huge left hand grasps the thigh, a thrust of the long, straight knife, two or three rapid sawing movements, and the upper flap is made; under go his fingers and the flap is held back; another thrust, and the knife comes out in the angle of the upper flap; two or three more lightning-like movements, and the lower flap is cut; under goes the great thumb and holds it back also; a touch or two of the point and the dresser, holding the saw by its end, yields it to the surgeon and takes the knife in return; half a dozen strokes, and Ransome places the limb in the sawdust. 'Twenty-eight seconds' says William Squire. 'Twenty-seven' says Buckell, a student still living. 'Twenty-six' echoes yellow-haired Russell Reynolds. 'Twenty-five seconds, Sir,' says proud Edward Palmer, the dresser, to his surgeon, who smiles in reply. The femoral artery is taken up on a tenaculum, and tied with two stout ligatures, and five or six more vessels with the bow forceps and single thread; a strip of wet lint put between the flaps, and the stump raised. Then the handkerchief is removed from the patient's face, and, trying to raise himself, he says: 'When are you going to begin? Take me back; I can't have it done.' He is shown the elevated stump, drops back and weeps a little; then the porters come in, and he is taken back to bed. Five

> minutes have elapsed since he left it. As he goes out, Liston turns again to his audience, so excited that he almost stammers and hesitates, and exclaims: 'This Yankee dodge, gentlemen, beats mesmerism hollow.''

The 'Yankee dodge' soon became a general practice. Methods and apparatus were improved and continue to improve, so that now the patient can sit up and chat whilst an operation of which he feels nothing is being performed, or forgetting all his troubles as if lulled with a true nepenthe, he can grow pleasantly drowsy and fall sound asleep until all is over.

The first anæsthetic in general use was ether. Chloroform was popularised by James Young Simpson, to whom it was recommended by a chemist of Liverpool, and whose experiments on himself and his friends were reminiscent of the ether frolics. The chloroform was prepared for Simpson by the Professor of Chemistry at Edinburgh, William Gregory (a son of the Dr. Gregory who gave his name to Gregory powder.) Simpson, in the face of much opposition, used it in cases of childbirth, not as an anæsthetic but as an analgesic, that is to say, not to produce complete unconsciousness but to relieve the severity of the pain. He had titanic arguments with the Churchmen, who insisted that the pains of childbirth were ordained by God (with some unacknowledged assistance from the Victorian corset) for redemptive purposes, of which the female alone stood in need. But argument was silenced when, on April 7th, 1853, Simpson gave chloroform to Queen Victoria during the birth of Prince Leopold. Even the Churchmen could hardly insist openly that the virtuous young Queen was in need of peculiar redemption, and chloroform à la Reine, as this use of it came to be called, could not henceforward be other than respectable.

3. The Revolution in Surgery

"We hold him for another Heraklcs,
Battling with custom, prejudice, disease,
As once the son of Zeus with Death and Hell."
(W. E. Henley)

Fear of pain had been removed by anæsthetics, but the fear of death remained. Taking a general average of such figures as are available it seems to be no exaggeration to say that out of every hundred operations performed in hospitals nearly fifty were fatal. Of course some hospital records were much better than others, so were the records of certain surgeons; and the patient operated on in his own home had a far better chance of recovery than the hospital patient. But there are records that make the fifty per cent hospital average seem an understatement. Newsholme (in *Modern Preventive Medicine*) states that, out of 13,000 amputations performed by the French surgeons in the Franco-Prussian War, 10,000, nearly seventy-seven per cent, were fatal. In the Glasgow Infirmary out of every ten patients admitted with compound fractures nine succumbed to a fatal gangrene. Nor was this terrible mortality limited to surgery. In Vienna there were two lying-in hospitals. In one, used as a training-school for midwives, the mortality was three per cent, in the other, a training-school for medical students, it averaged ten per cent and in some months rose to the dreadful figure of thirty per cent.

Puerperal fever, hospital gangrene, pyæmia, septicæmia, and tetanus were not merely a hospital nightmare, but everyday occurrences not calling for comment. The formation of pus was looked upon as an essential stage in the healing process, and the stench of putrefaction in surgical wards was accepted as inevitable.

Nothing of this is surprising when the surgical practice of the day is looked at in the light of modern knowledge. Liston feeling the edge of his knife against his thumb-nail, and the ligatures threaded through the house-surgeon's buttonhole to dangle over his coat, are horrifying enough, but worse things happened. J. R. Leeson, who was a student at the newly-built St. Thomas's Hospital, opened in 1871 by Queen Victoria and staffed by the carefully-trained Nightingale nurses, describes the velvet-lined cases, stained with blood and pus, in which the dressers carried their instruments, and the ward sponge that was passed from case to case—it was particularly useful for wiping ulcers—with no more cleansing than being squeezed out in warm water. He also tells the tale of a frock-coat worn by one of the surgeons for operating, which was considered a dirty business. The coat started its hospital career in the lecture theatre as part of the formal attire of the anatomy lecturer. When it became too shabby for such occasions he wore it in the dissecting room, where, during the course of demonstrations, it became stained with pus and putrefying tissues. When it became too dirty even for this purpose he hung it on the door of his room and changed into it only when he operated. It was regarded as an enviable possession, and was frequently borrowed by his colleagues, to save soiling their own clothes. No, when all is considered, it is not the death rate in hospitals that is surprising, but the number of survivals.

The first operation performed in England under an anæsthetic is commemorated in a picture that hangs in University College Hospital, where it was performed. It shows Robert Liston in the centre of a group of distinguished surgeons, arrayed in long frock-coats, high collars, and large ties. In the background, leaning forward, utterly absorbed in what is going on, is a student. His face is unusually beautiful, and, young though it is, it already expresses two dominant qualities, gentleness and concentration. It is the face of the young Quaker student Joseph Lister, who was to revolutionise the art of surgery.

Like many great innovators he had a forerunner. In the year 1846 Ignaz Philipp Semmelweiss (1818-1865) was an assistant physician at the Lying-in Hospital at Vienna. He was a delicately balanced, highly strung man, and the terrible mortality rate in the hospital was a fact that he could not accept calmly. Surely there was a reason for it, and the reason must be sought relentlessly, as a criminal is hunted. One feature of the mortality rate struck him at once. The lying-in hospital was in fact two hospitals, and the death rate in the two was widely different. In the section of the hospital where medical students were trained, and where daily post-mortems were held, more than three times as many women died of puerperal fever as in the other section, where midwives were in charge, and no post-mortems were held. Then, within a year of his arrival, his friend Kolletschka, Professor of Medical Jurisprudence, died of blood-poisoning contracted from a pricked finger incurred during a post-mortem. At once the similarity of the symptoms of blood-poisoning and of puerperal fever struck Semmelweiss. With unerring intuition he leapt to the conclusion that puerperal fever was a type of blood-poisoning, and that the students, going straight from post-mortems to the lying-in wards, carried infections from the putrefying bodies they had just handled to the women they examined. This would explain why women whose labour was so short that no examination was performed did not contact puerperal fever, why the mortality rate was so much lower in the hospital where there were no post-mortems, and why it always decreased during the vacation.

Semmelweiss immediately decreed that before conducting an examination every doctor or student in his department must disinfect his hands with chlorine water. At once the death rate fell. His conjecture had been right, and he had discovered both the nature of puerperal fever and the means of avoiding it.

The great discovery was published in 1861 under the title *Aetiologie, Begriff, und Prophylaxis des Kindbettfiebers*, but the publication aroused nothing but opposition. Accoucheurs became his bitter enemies—he stigmatised them as murderers, including himself in their number; promotion in Vienna was denied him; and although in a few years time he was appointed Professor of Midwifery in the University of Buda-Pesth, the tragedies he had played a part in, and the struggle that followed his attempt to make them a thing of the past, were too much for his sensitive mind. It gave way under the strain, and he died in an asylum at the age of forty-seven, strangely enough of the very disease that had carried off his friend Kolletschka and that had pointed the way to the prevention of puerperal fever. In the year that he died Joseph Lister was reading, with a growing consciousness of revelation, Pasteur's researches on the function of micro-organisms in the process of fermentation and putrefaction.

Many delightful biographies of Lister are available, and, pleasant though it would be to linger over the more intimate aspects of his life, the purpose of this short sketch will be better met by some account of the trends of thought that led to the development of what is sometimes called Listerian surgery, but what he himself called the antiseptic method.

In this sequence his education is important, for attitudes of mind, so we are told, have their inescapable beginnings in childhood, either in the pleasant atmosphere of example and encouragement, or in the stormier climate of antipathy and revolt—alternatives that give the psychological biographer plenty of scope. Lister's mind grew in the former. His mother was educated above the level of the average woman of her time. She had been a teacher in the Friends' School at Ackworth, where, on occasion, the north-country 'Friends' had flocked to hear her beautiful readings in the old school hall. His father, a wine-merchant in London, was one of those leisure-hour scientists who pursue knowledge for the love of it, and sometimes make discoveries that elude more purposeful pursuit. His special realm was microscopy, and he made a considerable contribution to the design of the compound microscope.

From his infancy Joseph Lister was encouraged in an interest in natural history. He learnt to dissect, to observe, not only with the naked eye, but also with the eye of the microscope, and to record accurately. When he came to practise surgery, for which he felt an early vocation, he practised it in the scientific spirit that derived from Harvey, and which the *Lancet* was to call 'truly Hunterian.' His formal education was unhurried. He went to Friends' schools at Hitchin and Tottenham, and, at the age of seventeen, to University College, London, then known as 'the godless university', for it was the only one open to students who were not, by profession at least, members of the Church of England. Here, at his father's wish, he took his arts degree before embarking on his medical studies, and it was not until 1852, when he was twenty-five years old, that he took his London M.B. Almost immediately afterwards, however, he became a Fellow of the Royal College of Surgeons, and in the following year, after much deliberation, he went to Edinburgh to work under Professor James Syme, who had performed the operation on Professor Wilson described in a previous section of this chapter.

Appalled by the terrible mortality rate in surgical wards, Lister had already turned his attention to the problem of sepsis. He had studied the process of inflammation in the webbed foot of a frog and pored over microscopic sections of diseased tissues. In his hospital work he was confronted by the significant difference between the healing process in compound and in simple fractures, that is to say in those where the injury causes an uninterrupted connection between the bone and the outside air, and in those where it does not. He wrote later·

> "The frequency of disastrous consequences in compound fractures, contrasted with the complete immunity from danger to life or limb in simple fractures, is one of the most striking as well as melancholy facts in surgical practice."

He was puzzling over this problem when Dr. Thomas

Anderson, Professor of Chemistry at Glasgow, drew his attention to the publications of Pasteur dealing with the function of micro-organisms in the process of fermentation and putrefaction. Pasteur had already distinguished himself in the field of crystallography. He had also studied the diseases of wine, and had discovered that they were caused by micro-organisms, not self-generated as was frequently supposed, but carried by the air. Again Lister's words may be quoted·

> "Turning now to the question how the atmosphere produces decomposition of organic substances, we find that a flood of light has been thrown upon this most important subject by the philosophic researches of Monsieur Pasteur, who has demonstrated by thoroughly convincing evidence that it is not to its oxygen or to any of its gaseous constituents that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life, long since revealed by the microscope, and regarded as merely accidental concomitants of putrescence, but now shown by Pasteur to be its essential cause, resolving the complex organic compounds into substances of simpler chemical constitution, just as the yeast-plant converts sugar into alcohol and carbonic acid."

Here, then, was the answer to the problem of why putrefaction occurred in compound fractures and not in simple ones, where the intact tissues protected the wound from contamination from the air. Lister's explanation cannot be improved upon:

> "If we inquire how it is that an external wound communicating with the seat of fracture leads to such grave results, we cannot but conclude that it is by inducing, through access of the atmosphere, decomposition of the blood which is effused in greater or less amount around the fragments and among the interstices of the tissues, and

> losing by putrefaction its natural bland character, and assuming the properties of an acrid irritant, occasions both local and general disturbance. . . . We know that blood kept exposed to the air at the temperature of the body, in a vessel of glass or other material chemically inert, soon decomposes. . . . It may be ascertained as a matter of observation that, in a compound fracture, twenty-four hours after the accident the coloured serum which oozes from the wound is already distinctly tainted with the odour of decomposition, and during the next two or three days, before suppuration has set in, the smell of the effused fluids becomes more and more offensive. This state of things is enough to account for all the bad consequences of the injury."

In the year 1860 Lister was appointed Regius Professor of Systematic Surgery in the University of Glasgow, a post he held for nine years, and it was during those nine years that he began to put into practice his antiseptic system.

Assuming that Pasteur's hypothesis was correct—and it was by no means generally accepted—that putrefaction was caused by micro-organisms carried by the air, the problem, as Lister saw it, of avoiding putrefaction was the problem of the destruction of the micro-organisms. Pasteur had shown that they could be destroyed by heat, and had made practical use of the discovery by applying a system of 'pasteurisation' to wine, keeping it at a raised temperature for a certain length of time, a system still in general use for milk. Pasteur had also discovered that micro-organisms could be filtered out of the air by passing it through pads of cotton-wool, or by passing it through tubes curved in such a way that they were deposited on the sides of the tube by the action of gravity. Lister frequently used this experiment as an illustration to his lectures. He describes it as follows:

> "I introduced portions of the same specimen of urine into

four flasks. . . . After washing the urine from their necks, which were then wide and straight, I drew out the necks by means of a spirit lamp into tubes about a line in diameter, and in three of the flasks bent these elongated and attenuated necks at various acute angles. . . . In the remaining flask the neck was cut short and left vertical in position, but its orifice was reduced to even shorter calibre than in the others. Each flask was then boiled over the lamp, and the fluid maintained in a state of ebullition for five minutes, the steam issuing freely from the orifice. The lamp was then withdrawn, and atmospheric air was permitted to rush into the flask to supply the place of the condensed steam. The flasks were then left undisturbed in the same room, the ends of their necks being still open so as to permit free entrance and exit of air as a consequence of the diurnal changes of temperature, which, of course, involved alternate expansions and condensations of the contained gases. Sometimes on a cold night I have raised the temperature of the apartment considerably, and then, putting the fire out, have thrown open the windows so as to occasion a depression of temperature of twenty degrees, involving the entrance of about a cubic inch of fresh air into the body of each flask. . . . And what has been the action of the air upon the urine? In the flask with straight and short, though narrow neck, I observed after ten days a minute filamentous object at the bottom of the glass. It grew larger from day to day, and was evidently a kind of minute vegetation, and on applying a pocket magnifier it was seen to consist of delicate branching threads. Four days after this growth first appeared, I observed an object floating on the surface of the liquid, evidently also a minute fungus. . . . Meanwhile the urine had been undergoing a change in chemical constitution, as was indicated by an alteration of its colour from a pale straw to a deep amber tint. But in the mean-

> time what was the condition of the urine in the three other flasks, with bent necks? . . . (After six months) it is perfectly clear and bright, free from cloud, scum, or sediment, and it retains its original straw colour, contrasting strikingly with the amber tint of the other. . . . It can hardly be doubted that this unaltered appearance of the fluid is associated with absence of putrefaction."

It may be mentioned here that Lister carried these flasks with him to his various lectures for many years, and when he and Mrs. Lister made journeys by rail or cab they balanced them carefully on their knees. They travelled with him when he returned from Glasgow to Edinburgh in 1869, and when in 1877 he took up an appointment at King's College, London, they were transported there, still pure and uninfected, by his senior house-surgeon, Watson Cheyne. Their eventual fate, unfortunately, is unknown.

The story of the flasks anticipates a little, for the lecture at which he first produced them was given in Glasgow in the spring of 1868, nearly a year after the publication in the *Lancet* of his first paper on the antiseptic principle, and nearly three years after his first application of the principle in the treatment of a case of compound fracture. The problem of destroying the organisms that infected wounds, and were thus demonstrably present in the air, was no simple one. Boiling and filtering were out of the question. They must, if possible, be destroyed by chemical means, and the chemical used must destroy the organisms without destroying the tissues of the body. Again we can turn to Lister's account:

> "In the course of the year 1864 I was much struck with an account of the remarkable effects produced by carbolic acid upon the sewage of the town of Carlisle, the admixture of a very small proportion not only preventing all odour from the lands irrigated with the refuse material, but, as it was stated, destroying the entozoa (parasitic

> animals) which usually infect cattle fed upon such pastures. . . . My attention having for several years been much directed to the subject of suppuration, more especially in relation to decomposition, I saw that such a powerful antiseptic was peculiarly adapted for experiments with a view to elucidating that subject, and while I was engaged in the investigation the applicability of carbolic acid for the treatment of compound fractures naturally occurred to me. . . . The first specimen with which I happened to experiment was an impure liquid kind, sold as 'German creosote', and this was absolutely insoluble in water; the associated organic compounds having, apparently, too strong an affinity for the acid to permit water to appropriate any of it. . . . The public are much indebted to Mr. Crace Calvert of Manchester for his successful efforts to prepare carbolic acid in a pure form at a moderate price. Mr. Calvert's second quality of the crystallised product, sold wholesale at 1s. 6d. per pound, is sufficiently pure for surgical purposes."

The use of carbolic as a cleansing agent was not new; what was new was the principle that governed its use and dictated the thoroughness and attention to detail that even now sometimes strikes the layman as excessive, though his life may depend on it. Lister wrote a warning letter to the *Lancet*:

> "I may take this opportunity of warning some of your readers that they must not expect carbolic acid to act like a charm; but that, whether they employ this agent or some other of analogous properties, it is only by the light of sound pathology, and strict attention to practical details, that they can hope to attain in their full measure the magnificent results which the antiseptic treatment is capable of affording."

Having found an agent capable of destroying the micro-organisms that cause wound infections the next step was to devise convenient ways of applying it. In the early days all Lister's dressings had to be invented and prepared by himself. He discarded the 'cloths' collected by charitable townspeople and hitherto used for dressing wounds, in favour of lint, domet bandage, absorbent wool, soaked in carbolic solution and covered with pastes, metals, or proofed materials. For years he experimented with different types of dressing. He stripped lead from tea chests, procured book-muslin from book-binders, he went about with little dressings on his arms to find out to what extent they irritated the tissues. He even devised an antiseptic spray that enveloped patient, operators, and dressers in a cloud of moisture. But all the variations he introduced had but one object in view, the destruction of the germs that were the source of putrefaction and disease.

In 1867 he felt that the time had come to make public the methods he had first put into practice two years previously with significant success. He described them in a series of five papers which appeared in the *Lancet* between March and July under the heading 'On a New Method of Treating Compound Fractures'. Extracts from these papers, describing the general principle on which he founded his innovations, have already been quoted. He goes on to give an account of ten cases that he had treated in the years 1865-1867, describing them in the order of their occurrence, and "premising that, as the treatment has been gradually improved, the earlier ones are not to be taken as patterns."

The first person to benefit from antiseptic surgery was a boy of eleven, James Greenlees, who was admitted into Glasgow Royal Infirmary with a compound fracture of the left leg, caused by the wheel of an empty cart which had passed over the limb a little below its middle. His chance of recovery under the usual treatment was about one in five, and in any case his leg would have been amputated in order to reduce the risk of infection. Under Lister's new treatment he not only recovered, but kept his leg. Case Four was also a child, and the circumstances in which he was injured remind us of the social conditions that still prevailed less than a hundred years ago.

> "James W., aged ten, was engaged in a turner's factory worked by steam power, on the 8th of June 1866, when his right arm was drawn in between a strap and a shaft turned by it. He called out for assistance, but thinks two minutes must have elapsed before the machinery was stopped, and during the whole of this time the strap, which was still moving while he held the arm steady, was cutting into the ulna side of the forearm, breaking through the ulna about its middle, while the radius was bent with 'greenstick fractures'."

This case too would have called for amputation under the old methods, but instead the wound was dressed with carbolic, and the arm saved.

Shortly after the publication of the papers in the *Lancet* Lister addressed the British Medical Association at a meeting held in Dublin on the ninth of August, 1867, on 'The Antiseptic Principle in the Practice of Surgery,' in which he extended the principle, previously applied only to compound fractures, to abscesses, wounds, and surgical operations.

> "The results (of the antiseptic treatment of compound fractures) have been such as to establish conclusively the great principle that *all the local and inflammatory mischief and general febrile disturbance which follow severe injuries are due to the irritating and poisoning influence of decomposing blood and sloughs.* For these evils are entirely avoided by the antiseptic treatment, so that limbs which otherwise would be unhesitatingly condemned to amputation may be retained with confidence of the best results.
>
> 1. In conducting the treatment, the first object must be the destruction of any septic germs which may have been introduced into the wound . . . (by washing out with a solution of carbolic).

2. The next object to be kept in view is to guard effectually against the spreading of decomposition in the wound along the stream of blood and serum which oozes out during the first few days after the accident when the acid originally applied has been washed out or dissipated by absorption and evaporation (by covering with a paste of common whitening mixed with carbolic acid, and boiled linseed oil and over this a plate of clean metal) . . .

The next class of cases to which I have applied the antiseptic treatment is that of abscesses. Here also, the results have been extremely satisfactory, and in beautiful harmony with the pathological principles indicated above . . .

Ordinary contused wounds are of course amenable to the treatment as compound fractures . . .

If the severest forms of contused and lacerated wounds heal thus kindly under the antiseptic treatment, it is obvious that its application to simple incised wounds must be merely a matter of detail. I have devoted a good deal of attention to this class, but I have not as yet pleased myself altogether with any of the methods I have employed. I am, however, prepared to go so far as to say that a solution of carbolic acid in twenty parts of water, while a mild and cleanly application, may be relied on for destroying any septic germs that may fall upon the wound during the performance of an operation; and also that for preventing the subsequent introduction of others, the paste above described, applied as for compound fractures, gives excellent results . . .

Further I have found that when the antiseptic treatment is efficiently conducted, ligatures may be safely cut short and left to be disposed of by absorption or otherwise . . .

There is, however, one point more that I cannot but advert to—namely the influence of this mode of treatment

> upon the general health of an hospital. Previously to its introduction, the two large wards in which most of my cases of accident and of operation are treated were amongst the unhealthiest in the whole surgical division of the Glasgow Royal Infirmary, in consequence, apparently, of those wards being unfavourably placed with reference to the supply of fresh air; and I have felt ashamed when recording the results of my practice to have so often to allude to hospital gangrene or pyæmia. It was interesting, though melancholy, to observe whenever all or nearly all the beds contained cases with open sores these grievous complications were pretty sure to show themselves; so that I came to welcome simple fractures; though in themselves of little interest either to myself or the students, because their presence diminished the proportion of open sores among the patients. But since the antiseptic treatment has been brought into full operation, and wounds and abscesses no longer poison the atmosphere with putrid exhalations, my wards, though in other respects under precisely the same circumstances as before, have completely changed their character; so that during the last nine months not a single instance of pyæmia, hospital gangrene, or erysipelas has occurred in them.
>
> As there appears to be no doubt regarding the cause of this change, the importance of the fact can hardly be exaggerated."

There was no doubt in Lister's mind, and none in the minds of his house-surgeons and students. The facts had been so clearly stated that it seems astonishing that they did not carry immediate and universal conviction. A leading article in the *Lancet* was indeed tentatively favourable:

> "Professor Lister's idea of surgery," it ran, "is a truly Hunterian one. He is not a surgeon who can be content to consider his art as consisting in the skilful use of a knife.

> He claims, equally with the physician, the right to take assistance from physiology and chemistry; to expose life in all its forms, even its 'lower forms', which, we are now beginning to see, have much to do with surgery and with marring the success of some of its finest feats."

But the editor knew nothing of the 'lower forms' of life of which he wrote so glibly. Pasteur's germ theory of putrefaction was neither accepted nor understood at this date; indeed, it had not been demonstrably proved. Some surgeons tried the effects of carbolic, using it perfunctorily and with little success. Others declared that they obtained good results simply by paying due regard to cleanliness, which is not surprising, especially when what were accepted as good results are taken into consideration. The general misunderstanding of Lister's principles even amongst those who were prepared to accept his methods is illustrated by an incident, related by Greville MacDonald, that occurred during the first operation performed by Lister at King's College Hospital. Whilst Lister's attention was diverted for a moment from the patient to explain something to the watching students, one of his colleagues was on the point of touching the wound—a fractured knee-cap—with an unsterilised finger. Lister saw him just in time and pushed him away with some violence. He then sterilised his own hands again, and continued the operation. This occurred ten years after the publication of his papers on antiseptic surgery, and shows how slowly his methods came to be understood.

After the first favourable notice the *Lancet* turned hostile. London was indifferent or antagonistic from the beginning. But to Glasgow, and subsequently to Edinburgh, where in 1869 Lister succeeded his father-in-law Syme in the Chair of Clinical Surgery, surgeons came from all over Europe to watch him at work and to learn the methods that were producing such amazing results. For in his wards hospital gangrene had become a thing of the past, cases of pyæmia were rare, and wounds healed by first intention as a matter of course.

Lister, unlike his contemporary Simpson, was no controversialist, and his publications were meagre. He concentrated on improvements in his methods, and the training of house-surgeons and students. Here he was in his element. There was no need to argue where the facts spoke so eloquently for themselves. In one of his lectures he told his students:

> "You are as competent as you ever will be to draw logical inferences from established data. Do not, then, let any authority shake your confidence in knowledge so obtained."

So appealed to, they responded as young people do to reason rather than authority. They held him in awe, but they admired and trusted him, and their belief in the antiseptic principle became impregnable. He was admired and trusted, too, by his patients.

> "Every patient that comes under your care," he told his students, "should be treated with the same consideration and attention as though he were the Prince of Wales himself, and if you are not willing to practise your profession in this spirit I pray you leave its sacred ranks and betake yourself to some third-class trade."

When Queen Victoria became his patient she received no more careful attention than he bestowed on the poor of Glasgow and Edinburgh, and it was enough to impress the little Empress.

But it was the children who really loved, and in their way understood, him, for he was a shy man, and only with them could he discard his natural reserve. There is a story of a little girl in his ward whom he found sobbing because the nurse had taken away her doll. The doll, it appeared on enquiry, had been damaged and its sawdust stuffing was leaking through a hole in its calico body. It was a case for surgical intervention. Lister called for needle and thread, sat down on the child's bed, sewed up the rent with the skilful care he had acquired in suturing wounds, and returned it to its owner as carefully mended as if it had been human.

Meanwhile in spite of all the available evidence London continued to look askance at antiseptic surgery. In 1877, however, Lister received an invitation to fill a newly created Chair in clinical surgery at King's College. The invitation held few inducements. He would have fewer hospital beds, little or no private practice, hostile fellow-practitioners. But it offered the one inducement that, to a man of Lister's character, was all-important—the opportunity to convince his antagonists by practical demonstration. In the summer of 1877, taking with him two house-surgeons, two dressers, and of course the famous flasks, he left Edinburgh for London.

It was uphill work. In place of sixty or seventy patients he had twenty-four empty beds. Opposition was bitter and prolonged; recognition of the incalculable worth of the antiseptic system dawned but slowly. In Germany, however, his work was admired and developed, and it was there that the spotless operating theatre of today first came into use. German methods in their turn influenced London, and at last Lister's work received universal acceptance.

In 1880 he was made a D.C.L. of Oxford and an LL.D. of Cambridge. In the same year he received a baronetcy, and in 1897 a peerage, the first medical man to receive such an honour. Perhaps the greatest acclamation he ever received was at the Sorbonne, when he presented an address from the Royal Society to Louis Pasteur on his seventieth birthday. In front of an audience wild with delight the warm-hearted Frenchman embraced him and kissed him on both cheeks—something of an ordeal, possibly, to one with a Quaker upbringing. On this occasion, too, he persuaded Pasteur to bury the patriotic hatchet and shake hands with his great German colleague Robert Koch. So three of the greatest men of that illustrious century met, and who can say, with any certainty, that he does not owe to them his life and health?

CHAPTER TEN

'Most Wonderful Living Creatures'

> "*There are more animals living in the scum on the teeth in a man's mouth, than there are men in a whole kingdom. Especially in those who don't ever clean their teeth.*"
>
> (ANTONY VAN LEEUWENHOEK)

IN writing, in the previous chapter, of micro-organisms advantage was taken of the fact that the reader, in one way or another, was familiar with them. Under various designations they are bandied about in everyday speech; in the laboratory they are as carefully documented as criminals at Scotland Yard. But Lister's knowledge of the enemy he so successfully routed was neither so familiar nor so exact, and it was not until 1876, when Koch completed his research on the anthrax bacillus, that the search for the microbes of disease began to be widely and systematically undertaken. But if the work of Koch and his contemporaries, and the curative means in the modern medicine chest are to be seen in perspective, a backward step must now be taken to pick up a few essentials in the story.

Micro-organisms are, by definition, individually invisible to the naked eye, and man, who began his investigations into nature ill-equipped in everything save curiosity, had to do some profound thinking before they could take their place in his view of the process of disease. The microscope was evolved by way of spectacles and the telescope, which Galileo (1564-1642) adapted and Malpighi (1628-1694) applied to anatomical research. (The invention of glass-making is passed over, wonderful though it must have been.) The first man who actually saw and described the hordes of animalcula that the eye of the microscope revealed was a Netherlander, Antony van Leeuwenhoek (1632-1723).

He was, by trade, a draper in the town of Delft. He also held some minor post at the town-hall, but it may be assumed that these responsibilities—perhaps discharged partly by substitutes—left him ample time for the pursuit of his favourite occupation, which was making lenses, and watching the curious things that became visible when he looked through this extended eye. He ground hundreds of lenses and mounted them as microscopes, and they were certainly the most powerful that had so far been manufactured. Then he sat for hours peering through them at any substance that came handy. He saw infusoria in drops of water, bacilli in the pickings of his teeth—less abundant, he noticed, when he had just been drinking hot coffee. It was a fascinating new underworld of 'Beesjes' or 'Cleijne schepsels', beasties or little creatures. (It is indeed a sight that still offers more variety than the cinema, and can be recommended as entertainment.) With their function he was not greatly concerned, but their various shapes, their motions, and their habitats never failed to interest and delight him. He drew and described them, and wrote long letters about them to the Royal Society, now flourishing in the enlightened England of Charles the Second. In all he wrote them 375 papers, and he sent them a present of twenty-six of his second-best microscopes. When they published his papers in their *Philosophical Transactions* he was vastly gratified, and when, in 1679, they elected him a Fellow he felt very proud, for in the view of most of his contemporaries he was, since he knew no Latin and must write of his discoveries in his native language, an unlearned Dutchman, whilst they were the elect of science. Whatever his own secret views on the matter were, he knew for certain that he could grind lenses that were better than any others in the world.

Leeuwenhoek's accounts of his 'little beasties' were read with interest by Doctor Benjamin Marten, a physician who carried on his practice in Theobald's Row, near Red Lion Square, in London. Doctor Marten also possessed a microscope, and enjoyed looking through it in his leisure hours. His microscope was not as powerful as those Leeuwenhoek made for himself in Delft, but it was powerful enough to show him the 'minute animals' that make 'furrows under the Epidermis or Scarf Skin' and so cause the 'Itch' or scabies. It was clear to him that these 'animals' were the agents that transferred the disease from one person to another. He wrote of them:

> "Some of these minute Insects, contain'd in a very small part of that Humour (in the little Bladders that arise in that Distemper between the Fingers), fixing upon a sound Person's Skin, either by shaking Hands with an Itchy Person, or wiping with the same Towel, or drawing on one of his Gloves, &c., will soon insinuate into the Pores, and there increase and multiply and quickly act the same Part in that Person, as in the other, from whence the Disease was received, as innumerable Examples convince us."

Doctor Marten argued that if the Itch were caused and transferred by minute animals, visible only under the microscope, other diseases might be caused and carried in the same way, by organisms still more minute, but which the microscope might eventually reveal.

All that we know of Benjamin Marten, M.D., is contained in his one small book, *A New Theory of Consumptions*, dated from his home in Holborn, September 1st, 1719. It was published in the following year, three years before Leeuwenhoek's death at the age of ninety-one, and a hundred and one years before the birth of Pasteur. In this book he argues the case for what is now called the germ theory of disease. He begins with a description of consumption, evidently a very prevalent disease even in Wren's new London, for it is clear that Doctor Marten had ample opportunities of studying it and had noted all its phases with a searching observation that would have done justice to a Sydenham. Having described it he goes on to speculate about its cause:

> "What this Peculiar, Primary or Essential Cause of a Consumption really is doubtless will be very difficult, if possible to ascertain; however, modern Discoveries and Microscopical Observations may assist us in our enquiries.'

It was a surmise substantiated one hundred and sixty-eight years later by Robert Koch.

Doctor Marten's work is not often quoted at any length, and since the language he uses takes us back better than any summary can do to his times and outlook, he shall speak for himself, and gain, we hope, more appreciation than when he wrote for an indifferent world some two hundred and thirty years ago.

Having explained the manner in which the Itch is carried from one person to another, he applies the principle to Venereal Diseases, which are also communicated by contact.

> "And I conceive . . . Venereal Disease to be communicated after the same manner; only as we may conjecture the Animalcula abounding in the purulent Matter flowing from the small Ulcers in that distemper are of a different Species, Shape, and Magnitude, from those of the Itch, they are not capable of insinuating themselves into the External Pores of many other Parts of the Body."

From the cause of Venereal Disease he proceeds to his principal theme, the cause of consumption:

> "The Original and Essential Cause . . . may possibly be some certain Species of Animalcula or wonderfully minute living Creatures, that, by their peculiar Shape, or disagreeable Parts, are inimicable to our Nature; but, however, capable of subsisting in our Juices and Vessels, and which being drove to the Lungs by the Circulation of the Blood, or else generated there from their proper Ova or

Eggs, with which the juices may abound, or which possibly being carried about by the Air, may be immediately convey'd to the Lungs by that we draw in, and being then deposited, as in a proper nidus or Nest, and being produced into Life, coming to Perfection, or increasing in Bigness, may by their spontaneous Motion, and injurious Parts, stimulating, and perhaps wounding or gnawing the tender Vessels of the Lungs, cause all the Disorders that have been mentioned. . . . Nothing is more certain than that there are innumerable Species of Living Creatures of various Forms or different Shapes and Magnitudes, that at their largest Growth are too small to be discerned by our naked Eye, and that, there being no such thing as Equivocal Generation as the Learned World now all agree*, every such minute living Creature must be produced from an Ovum or Egg, from whence it may easily be conceived that, as those little Animals at their full Growth are too small to be perceived without the help of Glasses, so their Ova or Eggs must be exceedingly smaller, and, consequently so light as to be capable of being carried to and fro in the Air, and be sucked in with our Breath, or be lodged in our external Pores, &c. . . .

Or those minute Creatures may perhaps deposit their Ova or Eggs in the Fruits of the Earth, and in the very Food that we eat . . . Nay, it will not be difficult to suppose it possible, that as the Fluids of our Parents might abound with many species of Animalcula, so the Ova or Eggs of them may have been communicated to us . . . even whilst we were in the Womb, and may possibly lie latent in us for a longer or shorter term of years. . . . And thus we may possibly account for several Diseases to which we are liable Hereditarily . . .

If it be once allow'd that the Plague, Pestilential and

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* NOTE. Pasteur, however, did not find the learned world in such harmony, and took some trouble to bring them to agreement on the point.

> other Epidemic Diseases are caused, and carried on by very minute volatile Insects we may then easily conceive how they are convey'd to and from Distant Countries or Climates, viz. by such Volatile Animalcula or their Ova or Eggs being deposited in the Bodies or Cloaths, or Goods of Travellers &C. It seems . . . that the minute Animals or their Seed which we have suppos'd to be the Essential Cause of a Phthisis or Consumption of the Lungs are for the most part either convey'd from Parents to their offspring Hereditarily, or communicated immediately from distemper'd Persons to sound Ones who are very conversant with them . . . It may here be properly objected, that if the Disease is communicated after this manner, few that come near a Consumptive Person would escape having the Distemper; but in Answer to this I imagine that slightly Conversing with Consumptive Patients is seldom or never sufficient to catch the Disease; there being but few if any of those minute living Creatures or the Eggs communicated in slender Conversations . . . besides, we may imagine that some Persons are of such an happy Constitution, that if any of the Ova of the inimicable minute Animals that cause a Consumption, happen to get into their Bodies, they may likewise be forced out again, through some of the Emunctories, before they are produc'd into Life, or else be wholly destroyed . . . I think I have said enough to evince the Reasonableness and probability of my conjectures . . . and to afford sufficient Hints to some abler Hand whose Abilities are more equal to the Task to carry the Theory much farther than I have done, and it may be bring it to absolute demonstration in an extensive Degree."

He had certainly said enough to evince the reasonableness of his conjectures, for they were founded on careful observation of the patient if not of the 'minute animals'. And he had covered a great deal of ground: the origin of parasitic diseases, droplet infections, heredity, the carrying of diseases in clothing, immunity, resistance to slender invasions, the possibility of ova (or spores), and even the need for an 'absolute demonstration' before his conjectures could be established. But, in spite of his able indication of fields of research, more than a hundred years were to pass before the 'abler Hand' was forthcoming and the 'sufficient Hints' were taken. Leeuwenhoek and Marten were both before their time, and the work they did was uncoordinated. Leeuwenhoek discovered the microbes without connecting them with putrefaction or disease; Marten suggested, with astonishing correctness, their function in disease but gathered no data about the microbes. Doctor Marten died and was forgotten, except by grateful patients to whom he seems to have ministered more rationally than most of his contemporaries, and Leeuwenhoek's little animals were remembered merely among the curiosities that entertained such enquiring folk as Pepys and Newton.

The years between Leeuwenhoek and Marten, and Pasteur and Koch were, however, by no means without progress. Scientific workers devised experiments the results of which, assembled fragment by fragment, were eventually co-ordinated into the science of bacteriology. The workers are so numerous, and the experiments so varied and interesting, that a book of considerable size would be required if justice were to be done to even the most outstanding. It seems more convenient, therefore, merely to indicate a few fragments of the mosaic that today shows a comprehensible, though still incomplete, pattern.

The nature of yeast was investigated, and it was found to be a microscopic plant that reproduced itself by budding, and in so doing brought about chemical changes, such as turning sugar into alcohol and carbon-dioxide in the preparation of beer. Animalcula of various kinds were studied, and particularly the conditions that favoured their growth or destruction. It was found that they could be grown in various infusions or broths, made with vegetable or animal substances; that they usually multiplied faster when kept at body temperature, but could generally be destroyed by boiling. If, however, the infusions were boiled and then exposed to the air, the animalcula reappeared after some time had elapsed, but if they were boiled and free air was excluded, they remained sterile. Animalcula must either have their origin in the air, or they must be generated spontaneously, out of nothing, as many, in spite of Doctor Marten's confident assertion to the contrary, still believed. This belief was finally shattered by a series of experiments that showed conclusively that if the infusions were boiled and then exposed to air that had been sterilised by heating, or filtered through cotton-wool, they still remained sterile. It was not the air, but something carried in the air, that engendered them.

That there was some connection, either of cause or effect, between disease and parasitic organisms became gradually apparent. A disease of silkworms known as muscardine was associated with a parasitic fungus; an outbreak of cholera in London was shown to have had its beginning in the water from a pump in Broad Street, Golden Square, presumably polluted by animalcula; microscopic, threadlike bodies were found in the spleens of cattle dead from anthrax. Again Doctor Marten's hypothesis was put forward, this time by a German, Jacob Henle (1809-1885). Henle knew, as Doctor Marten had known, and with a more informed conviction, that a scientific hypothesis, however logically convincing, requires material proof before it can be unquestioningly accepted as true. Through the years conceptions of proof had changed. For centuries scholars, nourished and exercised in the nebulous realm of theology, had accepted a logical argument as sufficient. The scientist of the nineteenth century required more. He insisted that facts should be the framework that supported hypothesis, and that hypothesis should not take precedence over facts, however insignificant.

Henle had very clear ideas as to what facts were necessary to establish the germ theory of disease. The causative microbe must be found. It must be cultivated, uncontaminated by other microbes; and this pure culture must be shown to be capable of producing the original disease. This outline of the necessary research was embodied in his *Pathologische Untersuchungen*, published in 1840, a hundred and twenty years after the publication of Doctor Marten's book on consumptions. It secured little more recognition than Doctor Marten's book had done, but it brought the discovery of the material of contagion appreciably nearer. For in 1852 Henle became Professor of Anatomy at Göttingen, and ten years later there arrived at that university an industrious young German student, Robert Koch, who learnt a great deal from Henle about scientific method, and also the requirements necessary to prove that a certain identified germ is the origin of a particular disease.

CHAPTER ELEVEN

Disease and the Microbe

"Only facts are the tests and touchstone of truth."
(THOMAS SYDENHAM)

ROBERT KOCH started his career as a country doctor. As District Physician of Bomst in Wollstein he held a position very like that of a general practitioner under the National Health Service. He had no specialised training, no laboratory, and no expensive equipment, yet he completed one of the most outstanding pieces of research of the nineteenth century. His story finds a prominent place here not so much because of the importance of his work, though that is beyond dispute, but because the work was begun, and the most remarkable achievement was actually completed, whilst he was in general practice. Nowadays the general practitioner is inclined to regard himself as the Cinderella of his profession, and it may do something to raise his self-esteem if he is reminded that many of the very men to whom he offers the highest tributes of admiration have been with him amongst the cinders, which, if he but knew it, may be diamonds but thinly disguised.

Heinrich Hermann Robert Koch was born in 1843 in the small mining town of Claustal in the Upper Hartz, the son of a mining engineer endowed with a high order of intelligence, and with a love of travel somewhat curbed by the responsibility for seven children, of whom Robert was the third. This love of travel he handed on in its full force to his third son, but long before it could manifest itself it became evident that Robert had also inherited his intelligence, for at the age of five he surprised the family with the announcement that, all unaided, he had taught himself to read, using the newspapers as his primers. The concentration and persistence shown by the child were equally characteristic of the man. The inspirational leaps of Pasteur were not for Koch. His work must progress by methodical steps, so thorough that they left no ground unexplored, no room for further argument.

His childhood was not luxurious, but it must have been reasonably comfortable. He attended the local 'Gymnasium' or high school, and, encouraged by his father, found time for collecting and classifying mosses and lichens, geological specimens, plants and insects; he also made a hobby of dissecting small animals. His boyhood occupations remind us of those of Jenner, except in the matter of formal education, for it will be remembered that Jenner left school at the age of thirteen, but Koch remained at his 'Gymnasium' until he was nineteen. When he left school the direction of his further studies was still in doubt. He had expressed a wish to study philology, for which his headmaster, Herr Direktor Elster, seemed to think that he had no particular gift, other than that of an accurate memory. Possibly philology suggested foreign travel to him, and for the same reason he might—to the world's loss—have become a merchant, for travel was the one thing that as yet he knew he wanted. But after a visit to an uncle at Hamburg, where he looked with longing at the big ships, he resolved to follow the advice of his headmaster, and when he went to Göttingen University the subjects he selected were mathematics and science. After two terms, he turned to medicine as a career that would give his scientific interests an outlet and at the same time provide him with a livelihood.

As a medical student Koch came under the influence of Henle, then Professor of Anatomy at Göttingen. He worked as his assistant in the Pathological Museum, where he had the benefit of his vigorous teaching, and no doubt at the same time studied with great interest his *Pathologische Untersuchungen.* His abilities were finding their direction, but his father seems to have been unaware of the fact. Announcing that he had written a prize essay involving a considerable amount of research, Robert wrote to him: "At our last meeting you seemed to have no great opinion of my general medical knowledge . . . but occasionally even a blind pigeon sometimes finds a grain of corn."

In 1866 he took his medical degree, and then went to Berlin for the customary six months of clinical study, during which he attended a course on pathological anatomy under Virchow, the leading pathologist of Europe. When the six months were up he was again attacked by one of his characteristic fits of restlessness. He was obsessed with the idea of travel, and the prospect of settling down to a humdrum medical practice did not attract him in the least. The possibility of seeing something of the world as a ship's doctor or an army surgeon occurred to him, and he took a post in one of the Hamburg hospitals, so that he could keep in touch with the shipping companies.

But he was by now engaged to marry a friend of his boyhood, Emmy Adolfine Josefine Fraatz of Claustal, and when he suggested to her that they should go abroad she firmly refused. Her idea of happiness was domestic comfort and a settled life. From the point of view of research this was just as well, but from the personal point of view it was a mistake, for though she made him happy for a time her domestic virtues failed to compensate him permanently for her fundamental misunderstanding.

However, for the time being all was well. Robert married his Emmy on the 16th of July, 1867, and they settled at Langerhagen, where he was physician to the asylum and also carried on a private practice, doing his rounds very pleasantly on horseback. Two years later, in the hope of financial betterment, he moved to the border town of Nymegen (now in Holland). But country doctors were not well paid in Germany, and he again found it difficult to make ends meet. He began to think of emigrating to America, as one of his brothers had done, but probably Emmy was again discouraging, for instead he went to Rakwitz, in German Poland. He was hardly settled before the Franco-Prussian War broke out. He served in a field hospital in St. Privat, in a typhus hospital in Neufchateau, and in a hospital for wounded in Orleans. But victory for the Germans was swift and decisive, and he was soon back again in Poland, carrying on his practice as before. He still felt—possibly Emmy told him—that he could do better for himself and his family, and after passing with great distinction the necessary examination he obtained the appointment of District Physician of Bomst in Wollstein. So far his success had not been outstanding, but, such as it was, he was anxious that his father should be impressed by it. He wrote:

> "I should not have wished to write to you about it until it was more positively established, had it not been that I wanted to give you an example to show how I enjoy in this neighbourhood a *not quite insignificant position* as a doctor. Although there are two doctors in Wollstein I already have a considerable practice here, and am nearly always called into consultation in difficult cases."

His 'considerable practice' in fact increased so rapidly that two other doctors decided to leave. There were only some four thousand inhabitants, and they were not getting their share of the patients since the advent of this brilliant and conscientious young man.

He remained in Wollstein for nearly ten years, and they were the most significant years of his life, for the research he did during that time determined not only his own career, but also the direction bacteriological research was to take for many years to come.

He must have been a busy man. He had the oversight of two hospitals and, for a time at least, the responsibility for some four thousand potential patients. In his spare time he made a special study of occupational diseases, and when the devoted Emmy, in one of her rare moments of understanding, made him a present of a Hartnack microscope, he turned his attention to algæ and infusoria. A letter to his little daughter Gertrud, his only child, gives a pleasant picture of this period of his life:

"Dear little Trudi,

I was very happy when Mama wrote and told me that so far you have been a good girl, and that she is pleased with you. I hope it will continue.

For your birthday I wish you much happiness. You are now eight years old, and from now on you must be a really sensible little girl, learn everything thoroughly in school, help Mother in the kitchen, tend the flowers, feed the animals, and polish my microscope glasses and collect algæ. You will manage all that, and as each year comes you will relieve us of more and more work. In the end Papa and Mama will be able to sit all day in easy chairs, and our dear little Trudi will cook for us, manage the microscope, and write prescriptions. Oh! that will be a lovely time. But meanwhile don't stay away any longer. The animals look every day in every corner, and Julka is always sighing, and often I think, when the door opens softly, 'Now my little girl is coming', and when I look up it is a stranger. So just come back soon to your dear

Papa."

In more senses than one it was a crowded life. The family of three occupied a four-roomed flat, and one of the rooms, divided by a curtain, served both as consulting room and laboratory. Here the rabbits and mice and frogs had to be accommodated, or it may be that they overflowed, somewhat to Emmy's inconvenience, into the kitchen. The microscope stood under the window, so that it could be illuminated by sunlight. Somewhere there was a cupboard heated by an oil stove, in which Koch produced his cultures. There must have been a dissecting table, and some means of sterilising instruments. And of course there were the patients. We may well marvel at Koch's capacity for detachment.

For it was in these cramped quarters and with these primitive means that he accomplished the research that demonstrated beyond all argument the origin of splenetic fever in the bacillus anthrax. The work was probably suggested by Henle's hypothesis of the material of contagion. Pasteur, it is true, had already declared certain diseases to be parasitic—that is to say due to micro-organisms; but before Koch could be convinced of the truth of this statement it must be adequately supported by facts, and among the preliminary facts required was the identification of the causative micro-organisms. He had not worked with Henle for nothing.

The choice of splenetic fever for his investigation was largely dictated by circumstances. It was a disease of cattle that ravaged the countryside in which he lived and worked, and it occasionally took its toll of those that tended the cattle. There was little difficulty in obtaining the blood and spleen of animals that had died of it, and by means of inoculation the disease could be communicated to small animals such as mice and rabbits, which are given to conveniently reckless breeding, and can be housed in the laboratory—or in the kitchen. To those who regret—and who does not?—that these pretty and inoffensive creatures should die in such numbers at the hands of the research worker it may be urged that the sacrifice of their little lives, uncomplicated by apprehensive suffering, has been the means of saving countless numbers of their fellow creatures, as well as men, women, and children, from sickness and untimely death.

That there was some connection between micro-organisms and the disease of anthrax was already known. Rayer and Davaine, working together at the Charité Hospital in Paris, had discovered that the blood of creatures that had died of anthrax contained millions of little thread-like bodies; and these had been further investigated by Pollender, a veterinary surgeon of Wippenfurth, who had actually measured them. But were these thread-like bodies merely concomitants of the disease, or were they its cause? They certainly communicated the disease, but it could also be communicated, as Brauell, a veterinary Professor at Dorpat, had demonstrated, by blood that did not contain them. It was known that there were pastures where no evidence of these organisms could be discovered, and yet these pastures were contaminated, and cattle that grazed in them caught anthrax and died. Evidently the problem was not a simple one.

Koch's first step was to prove to his own satisfaction that the organisms actually did communicate the disease. Somewhere a clue had been missed, and the only thing to do, as Koch saw it, was to start from the very beginning. Using a tiny sliver of wood, and making a small incision near the tail, he inoculated a number of healthy mice with a droplet of blood taken from the spleen of an animal that had died of anthrax. By way of control he inoculated a similar number with blood taken from the spleen of a healthy animal. In a few hours the mice inoculated with the diseased blood were dead, but those inoculated with the healthy blood were scurrying around as gaily as ever. The next step was to discover whether the thread-like bodies were present in the spleens of all the dead mice. Koch dissected them out, one by one, and examined them under the microscope. Yes, without exception all the little spleens swarmed with the organisms. In the spleens of the healthy mice there were none.

Again a number of mice were inoculated, this time with a spot of blood taken, not from diseased cattle, but from the spleens of the mice that had died of anthrax. Soon these mice were dead too, and on investigation their spleens were found to be swarming with the characteristic organisms. Koch found that the disease could be communicated in this way from mouse to mouse, and in every case the thread-like organisms could be passed on, multiplying in their millions and never losing their virulence.

But the blood that carried the disease in this murderous fashion contained more than one type of organism. If he were to be sure that only one type of organism communicated the disease he must inoculate with that type only, and to do that he must make a pure culture of it. This was no easy matter.

Previous investigators, including Pasteur, had cultivated micro-organisms in tubes of broths of various kinds, in which they multiplied, together with other chance organisms. It was impossible in a medium of this nature to be sure of isolating one organism, but it could be made preponderant if the 'sowing' were made from tube to tube, in series. This method was not exact enough for Koch's purpose. As a culture medium he used a drop of the clear liquid from the eye of an ox, which he suspended on a glass plate, covering it with another glass plate in which there was a small concavity. The plates were maintained at body temperature until the organisms multiplied. They were then 'sown' in another drop, and the process was continued until the culture could be considered uncontaminated. During the whole process Koch observed a technique of sterilisation of materials, which was something of a novelty at a time when Lister was still cleaning instruments and hands in solutions of carbolic. With the pure culture Koch began his inoculations all over again. It was unlikely that it contained any other organisms than those associated with anthrax, and it never failed to produce the disease.

He had now fulfilled the requirements that Henle had taught him were necessary before it could be assumed that an organism produced a specific disease. The organisms were always present in the diseased tissues, they were capable of being reproduced in a pure culture, and this pure culture invariably produced the disease. But an essential fact still remained unexplained, the fact that blood innocent of these organisms was also capable of producing anthrax. How was it that the disease arose, apparently spontaneously, in areas where no such organisms could be discovered? How was it that when conditions prevailed that destroyed the organisms the infection still persisted?

The possibility of the existence of eggs or spores had occurred to Koch. In such a form the organisms might lie dormant, and resistant to conditions that would otherwise have destroyed them. It was possible, but for Doctor Koch, working in his crowded laboratory, interrupted by patients, and surrounded by cages of little creatures, possibility was not enough. Theories, for him, must be adequately supported by facts. He set out on a new quest. The mice were put aside; they had served their useful turn. He now made a pure culture of the anthrax organisms in a sterilised drop of blood serum, and when this was done he placed it under the microscope, kept it at the required temperature, and watched, hour by hour.

For the first twenty hours nothing happened at all. Then the tiny threads began to develop into filaments, and in the filaments rounded bodies appeared. The filaments then divided horizontally, each section containing one of these rounded bodies. They might be the spores he had envisaged, but they might not. He must first see whether they were resistant to conditions that would destroy the thread-like organisms, and whether after undergoing such conditions they could, when conditions were made favourable again, develop into organisms capable of producing anthrax.

The spores were dried and put aside for several weeks. The anthrax organisms would not have survived this treatment, but when the spores were placed in a drop of the ox-eye fluid and kept at body temperature they developed into the characteristic thread-like forms, and were as deadly as those taken freshly from a creature just dead of anthrax. He had solved the whole complex problem. The disease of anthrax was communicated by thread-like organisms, as had been previously supposed. What had not been known was that they could lie dormant—possibly for years—in the form of spores, and then develop and cause a fresh outbreak of the disease.

But it was not until his experiments had been repeated again and again, and the proof established against all possible objecttion, that Koch made his discoveries public. Indeed he busied himself as much in trying to disprove his findings as in trying to prove them, for it was a characteristic of his peculiar talent to be able to foresee objections to his conclusions, and to devise experiments that decisively disposed of them. That this is now the accepted method in all research is largely owing to the influence of this, up to this point, obscure German doctor.

When, on the 22nd of April, 1876, Koch wrote to Ferdinand Kohn, Professor of Botany at the University of Breslau, requesting an interview, he knew that he had something of importance to demonstrate. He had had previous correspondence with the Professor on scientific subjects, and his request was not refused. He arrived with test tubes and re-agents, rabbits, mice, and frogs, and his Hartnack microscope. As soon as he started setting up his apparatus Kohn realised that his was the procedure of a man with a talent, if not a genius, for research. As the demonstration went on, Kohn sent for his colleague Kohnheim, Professor of Pathological Anatomy, and Kohnheim, in his turn, sent for his assistants. "You must leave everything and go to Koch," he announced excitedly, "this man has made a tremendous discovery which, in its simplicity and exactness of method, deserves all the more admiration since Koch is isolated from all scientific connections and has done all this on his own. It is absolutely complete in itself. Nothing more needs doing. I consider this the greatest discovery in the realm of micro-organisms, and I believe that Koch will astonish us again with further discoveries, and put us all to shame."

Professor Kohnheim was right. It was, and remains, one of the greatest discoveries in the field of bacteriology, and this country doctor was one of the greatest of the bacteriologists, qualified to stand beside the great Pasteur himself with stature undiminished.

He was not allowed to remain long in his rural obscurity. When his outstanding achievement became known, Kohn and Kohnheim, both men of influence in the scientific world, agreed that better facilities must be put at his disposal. After a short time at Breslau University, where he found it possible to do research but impossible to make a living, and an even shorter return to Wollstein, he was given, in 1880, an appointment at the Kaiserliches Gesundheitsamt (Imperial Sanitary Bureau) in Berlin.

Here he enjoyed not only more convenient quarters and more elaborate apparatus, but also the assistance of distinguished and able colleagues. Among them were Loeffler and Gaffky, the discoverers of the diphtheria bacillus and the bacillus of typhoid; Ehrlich, lately come from Breslau, where he had witnessed Koch's demonstration, and who was later to discover '606', the drug that destroyed the Spirochæta Pallida of syphilis; von Behring, who with the Japanese Kitasato was to discover anti-toxins for tetanus and diphtheria. They were a brilliant school and, under Koch's leadership, soon became world-renowned, not only for the discoveries they made, but also for the refinement and standardisation of those methods that Koch had begun to put into practice at Wollstein.

Before he left Wollstein he had published an important paper on this subject. Further improvements were made in Berlin. The hanging drop was supplemented by solid media such as boiled potato; infusions were made solid by the addition of gelatine, and as this dissolved too rapidly when exposed to moderate heat it was replaced by agar-agar, at the suggestion of the wife of one of Koch's colleagues, who had come across it for culinary purposes. The covered dish that bears his name was introduced by Petri, another colleague. These are all part of the standard equipment of the modern laboratory, and it is a matter of daily routine to dip a sterilised wire into infected material brought for investigation, make a criss-cross pattern on the jelly-like substance in the dish, put on the lid, and put it in the oven to grow. Organisms so distributed generally develop in colonies which can be separated and identified. The method is a great advance on the test tubes of broth in use when Koch first began his research on anthrax, and the advance is due to the high standards of accuracy he brought to the service of bacteriology.

Two completely new methods of identifying bacteria were ılso developed in Berlin—staining, which will receive more ıttention in a later chapter, and micro-photography. When

Leeuwenhoek wished to explain his 'beasties' to the Royal Society he had to draw and describe them. When Koch discovered the anthrax spores he had to watch his microscope hour by hour, and the process had to be gone through all over again at his demonstration in Breslau. But a micro-photograph gives a permanent record, and one that cannot incur the reproach of the subjective element.

Koch's first micro-photographs were taken by the sunlit window of his overcrowded room in Wollstein; in Berlin his method was developed with more effective apparatus; but it was J. E. Barnard, working in London, who first succeeded in photographing organisms so small that the waves of light pass round them, and are therefore illuminated only by radiations of a shorter wave-length, such as ultra-violet.

When he left Wollstein for Berlin Koch's life as a general practitioner was ended. His work henceforward was to be research, but that did not mean that it was confined to the laboratory. He worked at the Charité Hospital, and when, in 1885, he was made Director of the Institute for Infectious Diseases, he did a daily 'round', followed by students and assistants. Martin Kirchner, who took part in the round, described how carefully he examined each patient, and supervised the treatment, showing himself still the kindly doctor the patients at Wollstein had so deeply respected.

Two years after arriving in Berlin Koch startled the world by discovering the tuberculosis bacillus.

In spite of Benjamin Marten, the view of tuberculosis that was still accepted was that it was chronic, incurable, hereditary, but not contagious. There was no specific treatment for the disease, and in the Charité Hospital the patients received none, although in Berlin 14 per cent of the deaths were caused by it. Koch was not convinced that it was not infectious. It might, like anthrax, be due to an organism that could be transferred from one patient to another, and if so the organism must be found.

He set about his investigations in his usual painstaking manner. He examined under the microscope the sputum and excreta of living patients, and the tissues of those who had died, staining, cultivating, isolating, making micro-photographs. After two years of work he had reached his goal. He had found the tuberculosis bacillus. He had made other important discoveries as well. The tuberculosis bacillus could be found not only in the lungs, but also in joints and intestines. It was even found in patients who had not been thought to be suffering from tuberculosis at all.

He announced his results at a meeting of the Physiological Society of Berlin on the 24th of March, 1882. It was a very different occasion from that of the demonstration of the anthrax bacillus at Breslau five years earlier. Instead of a couple of professors and a few interested assistants, the foremost scientists of Europe gathered to hear him, and when the meeting was over, and the distinguished audience convinced, the news was flashed round the world by the electric telegraph. Patients came flocking to Berlin to be cured, but to find the cause of a disease is not necessarily to find the cure, and although cure is now not merely possible but frequent, an ideal substance that renders the tuberculosis bacillus harmless without injuring the patient is yet to be found. Koch's subsequent invention of Tuberculin, a glycerine extract of a culture of the bacillus, raised hopes that were soon found to be unjustified. Tuberculin, however, is far from useless. A modified preparation is of great value in testing cows for the presence of tuberculosis, and has made it possible to produce herds free from infection. Before many years have passed all the milk-producing cows in Great Britain will be free from the disease, and in more than one county this very desirable aim is already not far from attainment.

Tuberculin is also of great value in making early diagnosis possible, and so facilitating the prompt treatment that in a large number of cases meets with success. Between the year of Koch's discovery and the year of his death, 1910, the mortality from tuberculosis in Prussia had been reduced by half, largely as the result of the work done under his leadership at the Institute of Infectious Diseases.

It was not long after his discovery of the tuberculosis bacillus that the thirst for travel which Koch had found so disturbing in his youth at last began to be gratified. There was no need now to travel only for travel's sake, nor was it the adventure of big game hunting that took him abroad. It was the far more dangerous adventure of microbe-hunting.

An epidemic of cholera had broken out in Egypt and he was sent, with Gaffky, Fischer, and Trescow as his assistants, to investigate its cause, and to prevent, if possible, the spread of the disease into Europe. A similar but ill-fated mission, led by Thuillier and Roux, was dispatched from France. Thuillier, in the course of his work, caught the disease and died, and so was one of the first, though not by any means the last, to give his life in the dangerous crusade against epidemic diseases.

Koch and his assistants hunted the epidemic from Egypt to its focus of origin in India. In 1884 they returned triumphant to Berlin. They had found the comma bacillus of cholera, had traced its course to tainted water supplies, and in doing so had found the means, if not to cure, at least to prevent the disease.

On his return to Berlin Koch was honoured and fêted, and the importance of his work was recognised by an award from the State of 100,000 marks, £5000 at the rate of exchange of the period.

The journey to Egypt and India was the first of many. The home-loving Emmy had protested for the last time, and in vain. He settled her where no doubt she had always wanted to be, in the old home at Claustal, and in 1893 he married Hedwig Freiburg, who was more fitted both by temperament and education to share his travels and his scientific interests.

His microbe-hunting took him next to Africa, on the trail of malaria, which at that time made large areas of that continent uninhabitable for Europeans. He was sent to India again, this time to investigate the cause of bubonic plague; to German East Africa to find the cause of a cattle plague; and to Transvaal, the Orange Free State, and Basutoland on similar errands. His journeys of research took him also to Italy, Java, Kaiserwilhelmsland, German New Guinea, the Carolinas. In 1900 he was at home, investigating an outbreak of typhus in Berlin, but in 1903 he was back in Africa, at the head of a research team sent out by the British Colonial Office—an expedition that occupied two years.

Koch was beginning to realise that his duties in Berlin were discharged as often as not by others, and when he returned in the autumn of 1904 it was arranged at his request that Gaffky should take his place as Director of the Institute of Infectious Diseases, whilst he retained a laboratory and the services of an assistant. He was, in fact, to retire on a pension whilst remaining as a consultant.

He was now the leading bacteriologist in Europe, and the world-wide importance of his work was recognised by the award of the Nobel Prize, which he received in Stockholm in 1906. In the same year he was back in Africa, at the head of a Commission sent to investigate sleeping sickness, the origin of which in Trypanosoma Gambiense had previously been discovered by Bruce and Castellani, who had also discovered that it was carried by Glossina Palpalis, the tsetse fly.

He was already over sixty years old, but this life of travel and research still delighted him. By way of a holiday he decided, in the spring of 1908, to make a journey round the world. He crossed the Atlantic and the United States of America, and reached Japan, where he met his former assistant Kitasato, and was received by the Mikado. In Tokio he received a request from the German Minister of the Interior to attend a Congress on tuberculosis in Washington as leader of the German representatives. So it happened that he never travelled quite round the world, but if this were one of his ambitions it must have been one of the very few that were not attained.

He returned to Berlin in the autumn of 1908. On the 27th of May, 1910, at the age of sixty-six, he died of angina pectoris at Baden-Baden. He was, without question, one of the world's greatest scientists, whose typically German qualities of mind and character were devoted to the service of humanity.

A list of the more important of the organisms of disease that have been identified partly as the result of his pioneer work seems to provide a fitting conclusion to this chapter.

1873 Spirochaete Obermeierei (relapsing fever–Obermeier)
1875 B. Anthrax (Koch)
1880 B. Typhoid (Eberth)
1881 Staphylococcus (Ogston)
1882 Tuberculosis (Koch)
1882 Glanders (Loeffler and Schutz)
1883 Asiatic Cholera (Koch)
1883 Diphtheria (Loeffler)
1884 Typhoid (Gaffky)
1884 Pure cultures of Staphylococcus and Streptococcus (Rosenbach)
1884 Tetanus (Nicolaiei)
1885 Pure cultures of Neissers Gonococcus (Bumen)
1885 Bacterium coli commune (Escherich)
1886 Pure pneumococcus isolated and associated with pneumonia (Fraenkel)
1887 M. *melitensis* (Malta fever—Bruce)
1887 Meningococcus (Weichselbaum)
1888 B. enteritidis (Gaertner)
1889 B. tetanus cultivated and associated with the disease (Kitasato)
1891 Fungus of actinomycosis (Wolff and Israel)
1894 Plague b. (Kitasato and Yersin)
1896 B. botulinus (van Ermengen)
1898 Dysentery (Shiga)
1898 Bovine tuberculosis (Theobald Smith)

CHAPTER TWELVE

The Body's Defences

"*The art and practic part of life*
Must be the mistress of this theoric."
(HENRY V)

ROBERT KOCH and his fellow workers showed that microbes were the cause of at any rate a large number of diseases. But cause is not cure, and the patient gets little comfort from being told that he is suffering from a streptococcal infection unless at the same time he can be given something to stop the ravages of the streptococci.

Cure may be brought about in either of two ways. It may follow an actual attack of the disease, or it may take the form of prevention. The first is satisfactory and dramatic, the second more satisfactory and less dramatic. It must regretfully be admitted that the old adage "Prevention is better than cure" is apt to leave the patient cold, in spite of the fact that his very existence may depend on it, for without preventive medicine his grandparents might well have been killed off by smallpox or gaol fever, and then where would he have been? But that is not a problem of medicine.

Generally speaking, the first step towards cure, whatever form it may take, is the identification of the cause of disease—but not always. Smallpox was conquered long before it was recognised as a virus disease, and quinine cured many a case of malaria before the dire work of the female anopheles in carrying disease parasites was suspected. These, however, may be regarded as exceptions, and if the joint problems of prevention and cure are to be widely solved, the first step is to find the cause of the disease, the next to discover, if possible, the secret of immunity to it.

Immunology began, very unpromisingly, with the smallpox inoculators. To them must be allowed the credit of discovering that one attack of smallpox gave considerable protection against a second. If, in acting upon this assumption, they only succeeded in spreading the disease, they did at least demonstrate the possibility of protecting the individual, though at a dangerous cost to the community. It was this fact that impressed Jenner, and gave significance to the belief current in the countryside that cowpox gave similar protection. When, as a result of Jenner's activities, vaccination had become general it became possible to theorise to some purpose on this new mystery of immunity.

Louis Pasteur (1822–1895) was a great admirer of the work of Jenner. He looked upon vaccination not as an isolated fact, but as an illustration of a principle that might well be applied to other diseases. The organisms of cowpox, used by Jenner as a vaccine, might, he thought, be similar to those of smallpox, but reduced in virulence by passage through the cow. If so, then it might be possible to reduce the virulence of other micro-organisms in a similar way, and by using them as vaccines confer immunity to other diseases.

One of Pasteur's greatest gifts was an imaginative grasp of scientific truth, which, running with surprising certainty ahead of established fact, had much of the quality of prophecy. Six years before Koch's isolation of the anthrax bacillus he was declaring that parasitic diseases, that is to say, those caused by micro-organisms, would soon be at an end, not indeed cured, but prevented. It was a prophecy that has yet to be fulfilled, and the road to its realisation is longer and harder than he knew. But much of it has already been travelled. Jenner led the way, Pasteur followed the trail that he had made, and in their wake came the immunologists.

With the work of Jenner in mind, Pasteur began to experiment in methods of reducing the virulence of infections. The disease on which he concentrated was fowl cholera. It was a disease from which peasant farmers in his beloved France lost a considerable amount of money each year, and if he could wipe it out their economic security would be increased. It was convenient, too, in that fowls were convenient, if noisy, labortory subjects.

It had already been established by Perroncito that bacteria were the cause of the disease, and they had been cultivated in test tubes by Toussaint, a veterinary surgeon of Lyons. So much had already been accomplished. Pasteur began with attempts to weaken the strain of bacteria. Possibly this might be done by cultivating them in test tubes and sowing the culture from one test tube to another, without passing them through a live fowl. But after sowing them twenty times from one tube to the next, and then inoculating a fowl with a culture from the twentieth, the virulence of the strain was undiminished, and the fowl died, just as if it had been infected directly from a diseased fowl.

Pasteur then tried the effect of time on his cultures. He set the test tubes aside for a while before using them. It is said that he came upon this method by accident, but what is accident and what is design in the laboratory is hard to say, since both depend on the seeing eye and the creative impulse. However that may be, the method produced significant results. It was found that for at least a month the culture retained its vigour and produced the usual fatal disease. When, however, it was left for three months or longer the mortality amongst the inoculated fowls was considerably decreased. He then experimented with it as Jenner had done with the cowpox vaccine. First he inoculated his fowls with a culture of reduced virulence, and afterwards, if they recovered, as the majority did, he inoculated them with a virulent culture. The result was similar to that produced by vaccination: the first, mild, attack of the disease gave protection from the second. Evidently his surmise had been right. There was a principle underlying vaccination against smallpox that could be applied to other diseases.

So far as the chickens were concerned it was not an outstanding success, for, even with a culture that had been carefully attenuated, the protective dose, unlike that of cowpox, occasionally proved fatal. Nevertheless he appeared to be on the right road.

He next turned his attention to anthrax. It had the advantages from the research point of view that had appealed to Koch. It was a cattle disease that sometimes attacked humans, it could be communicated to small animals in the laboratory, and it devastated the cattle of France as well as those of Germany. Meadows around Chartres might remain ungrazed for months or even years, and yet when cattle were turned into them they contracted anthrax and died. It was as if some witchcraft were in the soil, and some peasants were prepared to believe that there was.

But Koch had already shown that the witchcraft was in the highly resistant nature of the spores. Pasteur's young assistants, Chamberland and Roux, found spores in the castings of earthworms, and realised that worms must carry them to the surface of the meadow from carcases of diseased cattle buried well below. The cattle absorbed spores as they grazed, the spores developed into bacilli in the blood of the cattle, and the trouble began all over again. But if, so reasoned Pasteur, a weakened type of bacillus were injected into the cattle before they were turned into the meadows, they might be able to resist the infection. A complication was added to the problem by the fact that it was essential that the weakened type of bacillus must be incapable of producing spores.

The ideal temperature for the cultivation of most disease-producing bacilli is body heat, about 37 degrees centigrade in humans (98.4° F.), between 38 and 39 degrees (100°-102° F.) in dogs and cattle, and a little above 39 degrees in rabbits and guinea-pigs. A temperature of 100 degrees centigrade (212° F.) maintained for about twenty minutes will destroy most, but not all, bacteria.

Pasteur tried the effect of gradually raising the temperature at which the anthrax bacilli were cultivated, and found that at a temperature of 45 degrees centigrade they could not be cultivated at all. A more critical temperature, however, was 42 to 45 degrees centigrade, for at that temperature the bacilli produced abundant growth but no spores, and when kept at this temperature for about a week they began to lose their virulence.

He tried this culture on a guinea-pig, and it proved harmless; on a rabbit, with no result. The rabbit was then injected with a virulent culture, and remained unaffected. Evidently the first injection had been protective. A more critical experiment was then tried on a sheep, and it met with the same success. Here, then, was the protective culture he was looking for and it was free from spores.

The time had come for more extended experiments and wider publicity. Pasteur, renowned and successful though he already was, was acutely aware of the widespread opposition he aroused in the scientific world. It was objected that he was neither a doctor nor a veterinary surgeon; no doubt the Germans objected that he was French, for the Franco-Prussian War was still lively in the memory. Pasteur admitted the first two impeachments with humility, the third with pride. But opposition must be met by a decisive and dramatic demonstration. The whole world must hear of his latest discovery.

His demonstration was staged at Pouilly-le Fort, a few miles from Paris, under the auspices of the Agricultural Society of Melun. On the 5th of May, 24 sheep, 1 goat, and 6 cows were inoculated with five drops each of a culture attenuated in the manner already described. On the 17th of May they were again inoculated, this time with a more virulent culture. So far all had gone well. The inoculations had been witnessed by a number of people, but there was little to see, for the animals suffered no ill effects.

The crucial test was fixed for May the 31st, twenty-six days after the first injections. An interested crowd, which included the *Times* correspondent, streamed out from Paris and the surrounding neighbourhood to watch whether this notorious

French scientist was indeed able to prevent infection from anthrax.

The thirty-one animals, already twice inoculated without noticeable result, were inoculated for the third time, and this time with a virulent culture calculated to kill any creature not immune to its effect. As an experimental control thirty-one similar animals (24 sheep, 1 goat, and 6 cows) were inoculated with an identical virulent culture.

Two days passed, and the spectators assembled again. It was a sorry sight. Of the thirty-one creatures that had not been previously inoculated with the weakened culture, the goat and 21 of the 24 sheep were already dead, two more of them died in the presence of the spectators, and the last of them at the end of the day. The four cows were feverish and unable to eat, and evidently in a critical state. In contrast to this holocaust the animals that had been previously inoculated were, with one exception, alive and perfectly well. The exception was one of the sheep, and a post-mortem disclosed that the cause of its death was not anthrax.

The experiment had been a dramatic success. A few weeks later, at the International Medical Congress in London, Pasteur described it in a paper on 'Vaccination in Relation to Chicken Cholera and Splenetic Fever'. He explained that he used the word vaccination deliberately, although it bore no relation to the vaccinia or cowpox that was the origin of the word, "as a homage to the merit and to the immense service rendered by one of the greatest men of England—your Jenner."

Inoculation as a preventive of anthrax was followed by inoculation as a preventive of swine erysipelas, the attenuation of the organism being achieved in this case by transferring the culture from rabbit to rabbit. But Pasteur had set his heart on carrying his treatment a stage further. He wanted to find an inoculation that would be effective after the disease had actually been contracted, not a preventive but a cure.

The disease he selected for experiment was rabies, a disease mainly of animals, but one that can be communicated to humans, and one of the most horrible and most feared. Charlotte Brontë, writing in the year 1849, describes the terror an accidental dog bite inspired in a woman normally far braver than most. It drove her to cauterise the wound with a red hot iron, to beg for "such a sure dose of laudanum as shall leave no mistake," to cry, "You know, in case the worst I have feared should happen, they will smother me . . . they will, they always do." If this is only a novelist's picture of the dread of the disease, it is drawn because she knew it would produce the required effect on the reader. Indeed, Shirley's dread was so well founded that laws were passed in France to make it a criminal offence to smother those who had contracted rabies. That the dread has been lifted we owe to Louis Pasteur.

The incubation period for rabies varies from fifteen days to eight months, and it was the protracted length of this period that gave Pasteur some hope that a vaccine might be found that would raise resistance to the disease after it had been contracted but before it had actually developed.

Following the pattern of the swine erysipelas experiments, the infective material of rabies was transferred from rabbit to rabbit. The effect, however, was not at all similar. The virulence, instead of decreasing, was increased, and the onslaught of the disease became progressively more sudden, until finally the incubation period was reduced from several months to six days. At this stage it became constant, and the virus showed no further modification; it had, as Pasteur expressed it, become fixed. Here, then, was a vaccine that satisfied one essential requirement: it worked rapidly enough for its effect to overtake that of the normally acquired infection. Unfortunately it was not protective, it was fatal. Other lines of research must be followed.

The seat of the infection was found to be not only the dreaded saliva of the mad dog, but also the central nervous system, the brain and spinal cord. The next line of investigation was directed to discovering whether the virulence of this infected material could be reduced by time. The spinal cord of a rabbit that had died of rabies after being inoculated with the fixed virus was found to be harmless after it had been dried in sterile air for two weeks. When dried for a shorter period it was not completely innocuous, but its virulence was abated. After continued experiments of this nature a protective treatment was evolved for dogs. They were inoculated in the first place with an emulsion of infected spinal cord that had been dried for fourteen days and was therefore harmless. On the following day they were injected with an emulsion that had been dried for thirteen days, and on the day following with one that had been dried for twelve days, and so on, until at the end of a fortnight they were inoculated with a virulent emulsion. The treatment was effective. The dogs were, for the time at any rate, immune to rabies.

The next stage was to apply the treatment to dogs who had already been infected with rabies. Again it worked. It was evident that the immunity overtook the infection and prevented the development of the disease. From that time rabid dogs were regularly treated.

But who dare apply the treatment to humans? After all, only a percentage of people bitten by rabid dogs actually develop rabies. The exact percentage is not known, for it is not always possible to find out whether a dog that has run wild and taken to biting is actually suffering from rabies—a point Charlotte Brontë makes use of in the story already quoted. Opinion in the laboratory was, on the whole, against subjecting human beings to doses of this deadly poison.

Then came a test case. On July 7th, 1885, Joseph Meister, an Alsatian boy of nine years old, was brought to Pasteur after he had been mauled by a dog that was without doubt rabid. The bites were deep and extensive on hands, legs, and thighs. Doctor Vulpian, the physiologist, and Doctor Grancher, the physician, assured Pasteur, that there was little or no chance of the boy's escaping a terrible death. With doubt lit up by hope Pasteur, against the advice of his physician-colleague Roux, supplied the vaccines to Doctor Grancher, who carried out the treatment. Inoculation with a fourteen-day-old virus was given sixty hours after the accident, and on the twelve successive days this was followed by inoculations of gradually increasing virulence. Identical inoculations were at the same time tested on rabbits. On the fourteenth day a dose of maximum virulence was given. The boy suffered no ill effects, but a rabbit similarly treated, but not previously inoculated, died in the minimum of seven days.

Joseph Meister recovered from his bites, and became, when he grew up, concierge of the Pasteur Institute in Paris. He lived to the age of sixty-five, and died in defence of the memory of his beloved Pasteur, for, rather than open to the invading Germans the crypt in which his body lay, he committed suicide.

It is not possible to say with certainty that Meister would have died if he had not received Pasteur's treatment, but it seems very probable. Contemporary opinion was practically unanimous. Large sums of money were subscribed by an enthusiastic public, and three years later the Pasteur Institute was opened in Paris. Here, between 1888 and 1935, 51,107 patients were treated for rabies, and of these only 151 died. Even the sceptic Koch, after making personal investigations, opened a similar department in Berlin. The nightmare of rabies was lifted from Europe.

Extravagant hopes were roused that all kinds of diseases could be similarly prevented or cured. It was the story of the Elixir of Life all over again. Scientists in their laboratories had only to discover the germs responsible for diseases, then make some magic concoction, and nobody would die from anything but accident or old age. But although a meteorite reaches the earth from time to time, even the scientists cannot catch the stars, though some of their achievements may bear the comparison.

Amongst the diseases that yield good results when treated by vaccines typhoid may be mentioned. During the Boer War 10 per cent of the troops on active service died each year from this disease. During the first German War the mortality was reduced by immunisation to .095 per cent. The vaccine used is no longer a weakened culture of live bacteria, but a suspension of dead bacteria, which has been found to afford similar protection without incurring, in any circumstances, the possibility of producing the disease. The preparation is made by isolating and culturing the bacteria, killing them by the application of heat, and making a saline suspension to which disinfectant is added. This vaccine is so innocuous that a dose of anything from five hundred million to a billion dead bacilli may be given without ill effect.

With the rapid development of the science of bacteriology and the advance made in the preparation of vaccines a need was felt for a science of immunology. It was important to find out, if possible, how the defence mechanism of the body worked. The problem has been found very complex, but certain facts bearing upon it have been established. Unfortunately any simplification of such an involved subject must bear some such distorting relationship to it as a child's drawing of a man does to the man himself, but in both cases some of the salient features can be illustrated.

Immunity has been shown to be of two types: active, or natural, immunity, which is enduring, though not necessarily permanent; and passive, or acquired, immunity, which is only temporary. Active immunity is produced by an attack of the disease itself. In some diseases the immunity thus acquired is sufficiently durable to make a second attack unlikely, but in others, such as influenza and the common cold, it is so fleeting that one attack may follow another with a negligible interval.

Active immunity is produced by vaccines, and is effective in the same way as an attack of the disease itself. Jenner's claim for vaccination was that it would "protect the constitution from subsequent attacks of Small Pox, as much as that disease itself" would. Its effect is not life-long, but it is of sufficiently long duration to prevent the disease spreading to any great extent in countries where vaccination is the general practice. In this connection it may be interesting to quote the figures published in the press concerning the Brighton epidemic of 1950. Of the ten patients who died, seven never had been vaccinated; the other three, all over fifty years of age, had been vaccinated in infancy only. Of the nineteen who caught the disease and recovered, eleven had never been vaccinated, six had been vaccinated in infancy only, one had been vaccinated fifteen years previously, and one two years previously, but the latter had the disease in so mild a form that for some time it passed unrecognised.

These figures are illuminating rather than conclusive, but they are sufficiently convincing to start queues for vaccination as soon as the alarm of an epidemic is raised.

There is a theory, not indeed absolutely established, that active immunity may be produced by sub-infective doses of disease. We are all—some of us more than others—in frequent contact with disease germs, but it takes more than one germ to produce a disease. The onset of disease may be looked upon as an enemy attack. If the defence is adequate the enemy is beaten off and no ill results accrue. The secret lies in the strength of the defence, and it is suggested that doses of bacteria, not sufficient to produce a disease, build up the body's defences, and so produce a certain degree of immunity. This theory would explain, what seems to be a fact, that country children, living in a relatively germ-free air, succumb to infection, when brought into contact with it, more readily than town children, who, as the result of occasional skirmishes, are better armed to meet the attack. It would also explain why native populations, brought suddenly into contact with infections carried from other countries, die with such appalling frequency from diseases such as tuberculosis, to which they have not been previously exposed.

Benjamin Marten remarked that casual contacts with tubercular patients were seldom dangerous. It seems likely that in these casual contacts resistance is built up, it may even be by attacks of the disease so slight as to be unnoticeable. Modern diagnostic methods have revealed the fact that most of us, at one time or another, have had an attack of tuberculosis, so mild as to pass for an ordinary cold, but sufficient to leave its mark on the affected tissues, and likely to render us immune to further attacks.

Passive immunity is not so much a personal possession as a borrowed one. The new-born infant, in the pre-natal state, acquires a considerable loan of immunity with its mother's blood, and for the first six months of its life is likely to be immune to the same diseases as she is, such as various childish ailments, and also diphtheria, a disease most common in the first two years of life. After about six months this borrowed immunity is lost. It may, however, be further prolonged, for the infant may continue to drink it in with its mother's milk.

An interesting experiment that illustrates this point was made with mice. Two pregnant mice were selected; one of them was immunised against diphtheria, and the other was not. When the litters were born they were exchanged, so that the immunised mother suckled the young of the mother who had not been immunised, and vice versa. After a time both litters were inoculated with diphtheria. Those born to the immunised mother, but not suckled by her, succumbed to the disease, but those suckled by the immunised mother, although not born to her, proved immune. It was evident that the immunity acquired in the pre-natal period was already lost, and equally evident that immunity was conferred during the period of suckling.

Another way of borrowing immunity that stands us in good stead when the disease has been contracted is by means of anti-toxins, and for these we are indebted to our old friend the horse, who, fortunately, is little the worse for the loan.

It was discovered in 1889 that the immediate disease agent, both of diphtheria and tetanus, was not bacteria but a poison, or toxin, produced by the bacteria. The bacteria themselves could be filtered out of the blood serum, leaving a clear liquid still capable of producing the disease when injected into healthy animals. It was further discovered that the immunity of rabbits and mice so injected depended on the capacity of their blood serum to manufacture neutralising agents, or anti-toxins. If blood serum were taken from rabbits who were already immune, and injected into mice, the mice could withstand doses of tetanus toxin that would otherwise have proved fatal. And what was true of tetanus was also found to be true of diphtheria. It was a discovery that laid the foundations of a method of immunising children to diphtheria that is likely, before long, to stamp out the disease, as smallpox was stamped out, for lack of susceptible victims.

The first person to be treated with diphtheria anti-toxin was a child in von Bergmann's clinic in Berlin on Christmas night of 1891. The child recovered. Since that first success bacterial toxins and anti-toxins have been standardised, and it is the horse, and not the rabbit, that supplies the serum. Diphtheria bacilli are cultured, the toxins they produce are filtered off, and small doses injected into healthy horses, who experience a temporary discomfort, but do not develop the disease. Gradually the doses are increased, and with the increase in the dose the immunity of the animal increases. Finally some blood is drawn off, left to clot, and the serum is tested and measured. This serum is highly anti-toxic, and is a valuable addition to the body's natural defences in the early years of life when children are most susceptible to diphtheria. When the disease has actually been contracted, the anti-toxin, particularly if given in the very early stages, increases the body's resistance, so that, in favourable cases, the toxic effects are neutralised.

The discovery of toxins and anti-toxins marks a stage in the elucidation of the problem of immunity. It is clear that serum taken from a creature that has been immunised by doses of toxins is anti-toxic, whilst serum from a creature that has been immunised by doses of microbes becomes anti-microbic. So much is fact, but the rest of the picture is less clear. Various hypotheses have been suggested to explain how toxins and bacteria function in the disease process, but they are no more than hypotheses and up to the present the process remains something of a mystery. Until this primary problem has been elucidated the related problem as to how toxins produce anti-toxins and how bacteria produce bacteria-destroying agents must also evade solution.

Ehrlich, seeing it from the chemist's standpoint, regarded the harmful products of bacteria as molecular structures having sharp or irregular projections—Martin had called them 'injurious parts'—which injured their surroundings. This concept included a complementary body, the anti-toxin, which fitted the toxic projections and so rendered them smooth and harmless, as a scabbard fits over the sharp blade of a sword. Since only the right scabbard would fit the particular sword, anti-toxic specificity would thus be accounted for. A modification of this theory is generally accepted today.

It is known that, in the process of digestion, proteins, which are necessary for the formation of body tissue, are broken down into amino-acids and then built up again. If introduced directly into the tissues, protein acts as a poison. Foreign proteins of this kind are called anti-gens, and the substances used for their destruction in the body tissues are called anti-bodies. Anti-bodies are specific for their own anti-gens, and as bacteria, small though they are, are sometimes composed of more than one anti-gen, or protein, it may take more than one variety of anti-body to destroy them.

Anti-serum, that is to say serum taken from blood rendered immune to a specific disease, may act on bacteria in various ways. The bacteria may lose their motility and agglutinate, and so become harmless, or they may be phagocytosed by polymorphonuclear leucocytes, or, to put it less sonorously, swallowed by the white blood corpuscles.

It was Metchnikoff, the Russian scientist, who discovered this process, by watching the white blood corpuscles ingest a fungus that attacked the water-flea, a transparent creature that makes no secret of its inner mechanism. Pus, which collects in large quantities about an infected injury, is full of leucocytes.

But leucocytes alone cannot destroy bacteria, 'complement' is also necessary, and complement is present only in fresh blood serum. 'Opsonin', another component of fresh blood serum, seems to be also necessary. These substances act on bacteria in such a way that they can be ingested by the phagocytes—the name given to bacteria-absorbing leucocytes. Resistance to disease, then, is not dependent entirely on stimulating the phagocytes; other factors are necessary, and these must generally be supplied in fresh blood serum.

It is only too abundantly evident that the number and complexity of the processes involved in immunity are, to the lay mind at least, very confusing. The problem is engaging research workers all over the world, and when, in years to come, it is solved, as it will be, the picture may be found to be far clearer and more simple than at present appears. All that has been attempted here has been to indicate a few faint outlines, which may or may not prove to be significant.

If we turn to the practical results already achieved there is no need for discouragement. Rice, in *The Conquest of Disease*, gives a list of the diseases actually conquered since the days of Jenner. It includes anthrax, Asiatic cholera, dysentery, diphtheria, hydrophobia, hookworm, leprosy, malaria, plague (Black Death), tetanus, typhoid, yellow fever, and we may add to these the achievement of Jenner himself, the conquest of smallpox.

CHAPTER THIRTEEN

The Modern Medicine Chest

"'Tis time new hopes should animate the world,
As at old games a runner snatched the torch
From runner still: this way success might be."
(BROWNING)

CHEMICALS in one form or another have been used as medicine for diseases since the days of the alchemists, who, with one eye directed towards the Philosopher's Stone and the other to the universal panacea, distilled and precipitated, digested and concocted, triturated and sublimated, in laboratories adorned with cucurbits, retorts, alembics, and stuffed alligators, until after much labour they begot the science of chemistry, and remedies became less haphazard. Emetics and purgatives have been in use since primitive times, and an aura of magic clung about them for centuries, which in the case of purgatives is scarcely yet dispelled. Soporifics and sedatives had, and still have, their function of mercy, digitalis has saved lives in times of need; but these remedies are directed to the alleviation of symptoms. None of them directly affect the actual germs of disease, which were left to the resources of the *vis medicatrix naturæ*, translated into modern terms as anti-bodies, and more recently reinforced both from within and from without by vaccines and anti-toxins.

But a few effective medicines for diseases that have since been recognised as parasitic have also been in use for a long time. The bark of the cinchona tree has been used as a remedy for malaria since, in the seventeenth century, it was brought from Peru by the Jesuits. It was uncertain in its effect because it was easily imitated, and could not be relied upon with confidence until quinine was isolated by the chemists in 1826. Ipecacuanha, still in use in the form of emetine, was known in

Brazil before the Spanish Conquest as an effective treatment for a form of dysentery that is now known as amœbic; and mercury was a favourite remedy with Paracelsus (1493–1541) three hundred years before Metchnikoff and Roux experimented with calomel on the spirochaeta pallida of syphilis.

It was accepted, then, that certain chemicals, introduced into the body, were beneficial in cases of parasitic diseases. It might be further assumed that such chemicals attacked bacteria in the same way as they were attacked by disinfectants in the laboratory, but without damaging the host, the unfortunate patient in whose organs the bacteria were multiplying, as the known disinfectants did. A large number of bactericidal chemicals were used as disinfectants during the last quarter of the nineteenth century, but they were useless as medicines because they were poisonous. If a chemical were to be found that would cure bacterial diseases it would have to be highly selective in its action; it would have to poison bacteria without damaging the body's tissues.

The selective affinities of chemicals is a matter of practical experience. It is particularly evident in dyeing even of the most amateurish kind, and there is no difficulty in realising that dyes have affinities with certain tissues or bacteria when it can be seen that an ordinary commercial dye may colour one material whilst leaving another unaffected. The story of 'The Man who ate the Popomack', a peculiar fruit that turned his face a vivid blue, is not incredible, though the probability is that, did such a fruit exist, its action would be on certain tissues rather than on certain areas of the body. He might have had blue nerve fibres, blue muscular tissues, or even blue blood, in which case the story would have been different.

However that may be, dyes, besides having an affinity for certain tissues, have an affinity for certain bacteria. Some are coloured by alkaline dyes, others by acid dyes, some by dyes that are neutral, and some, the spirochaeta pallida amongst them, are not affected by dyes at all. This selective action furnishes a convenient way of identifying them, and so assisting diagnosis. A short description of a test invented by C. Gram in 1884 will serve as an illustration.

A swab is taken from the affected part where the bacteria are likely to be thickly congregated, and a smear of the substance is dried on a glass slide. The bacteria are then fixed and killed by holding the slide in a flame. (It should never be forgotten that the pathologist in his laboratory works amongst substances as dangerous as those in an armament factory, and casualties are not unheard of in spite of the precautions observed.) The slide is then immersed in an alkaline dye, such as methyl violet, which colours the whole of the smear. It is next immersed in an iodine solution, which, if the bacteria are 'gram positive', will fix the colour in them. The next stage is to wash out the dye with alcohol. This removes the colour from everything but 'gram positive' bacteria, which, coloured a bright purple and standing out from a colourless background, can then be examined under a microscope. If, however, the bacteria are gram negative, the dye will have been washed out by the alcohol. The next test will probably be made with an acid dye, usually red. The racks of dyes in a pathological laboratory suggest the artist's studio rather than the pathologist's workshop.

Staining bacteria is not quite the same as killing them, though a stained bacteria is generally a dead one, but the fact that dyes are selective in their action furnishes a plausible argument for the selective quality of other chemicals; some chemical might be found that was deadly to bacteria and harmless to body tissues. This was the possibility that dominated the researches of Paul Ehrlich (1854–1915), a Russian Jew, who was born in Silesia, and studied in Breslau, Strasburg, Freiburg, and Leipzig. Even in his student days he took a passionate interest in the different effects of dyes on the tissues. Aniline dyes had been recently discovered, and his cousin, Carl Weigert, was a pioneer in staining methods. The thesis with which Ehrlich obtained his doctorate was on the use of stains in the microscopical examination of diseased tissues. His work, already remarkable, attracted the attention of Koch, whom he had already met on the occasion of his demonstration of the development of the anthrax bacillus at Breslau. Koch found work for him in research on tuberculin at the Charité hospital in Berlin, and later at the Institute for Infectious Diseases.

It was not long before he made a further contribution to medical science by establishing the fact that certain blood cells had affinities with alkaline dyes, others with acid dyes, and some with only neutral dyes. This discovery was of great importance both in diagnosis and in treatment, for the ratio of the different types of cells varies in different diseases of the blood.

From the staining of slides he went on to the staining of living tissues. Methylene blue, he found, when injected into living frogs stained the nerve fibres only, leaving the other tissues colourless. It occurred to him that the stain might have some beneficial effect on neuralgia; it was at least worth trying. But results were disappointing. Methylene blue had no curative action.

When, in 1896, a State institute was founded in Prussia with the object of conducting research on anti-toxic sera and standardising them, Ehrlich was made Principal, and the subject of immunity then engaged his attention. His talent for significant experiment soon achieved valuable results. Anti-diphtheric serum was standardised, and the principles of active and passive immunity were established. He demonstrated that both toxins and anti-toxins are strictly selective; toxins attack only those tissues for which they have a chemical affinity, and anti-toxins act only on those toxins that call them into being. Here he saw fresh evidence of selective chemical action in the human body and the possibility of a specific chemical remedy for parasitic diseases increased. What he had in mind at this time was probably a universal remedy, a bactericide that would be effective against all types of diseases caused by bacteria.

In 1899 he became head of the Royal Institute for Experimental Therapeutics at Frankfort-am-Main, to which, in 1906, the Georg Speyer Institute was affiliated. He had now three of what he described as the four G's necessary to success—*Geld*, money, supplied as a memorial to her husband by the widow of the banker Georg Speyer; *Geschick*, ability, with which he was amply endowed by nature, and in which his assistants were far from lacking; *Geduld*, patience, a characteristic of scientists everywhere; the fourth, *Glück*, was to be added as the natural consequence of the other three, for in science luck does not favour the unworthy.

After some work on the effect of dyes on trypanosomes he turned his attention to the treponema pallida, the pale spirochaete of syphilis, discovered in 1904 by Schaudinn. Syphilis had been the curse of Europe ever since, in 1492, Columbus had discovered America. It is far from certain that the events were connected, but Columbus supplies us with a memorable date which marks the fact that syphilis has not always afflicted Europe, and is not, therefore, connected with a sudden outbreak of sexual promiscuity, which was no worse at that time than it had been for centuries, and probably not as bad as in late Roman times, when syphilis was still unheard of.

The course of research was begun in 1906 in the Georg Speyer House, which had been built with that particular object in view. The drug which seemed to offer the likeliest possibilities was a form of arsenic known as atoxyl (p-aminophenyl-arsonic acid). It had already been tested with limited success on trypanosomes, and had also been found to have a curative effect on syphilis in rabbits and monkeys. Unfortunately, although it was to a large extent selective it was not sufficiently so, for it damaged, and sometimes destroyed, the optic nerve.

The problem, as Ehrlich saw it, was a problem of chemistry. Atoxyl, by a rearrangement of its molecules, must be chemically modified so that its lethal action on the spirochaete was preserved and its lethal action on nerve tissue eliminated. It was certainly possible to modify it in hundreds of ways, but whether any of these chemical modifications would have the desired result was not known.

It was a tremendous task, and in pursuing it the workers had no promise of ultimate success; all they had by way of encouragement was failure after failure. They were a brilliant team: Benda and Bertheim the chemists, Morgenroth the bacteriologist, the indefatigable Japanese Hata, and at their head Paul Ehrlich himself, dominated by his belief in the possibility of success. Some idea of the magnitude of the work may be gathered from the fact that at one stage the blood of hundreds of mice was microscopically examined for spirochaetes every day for a period of at least two months.

The difficulty that seemed no less insurmountable as the work proceeded was the damage the drug caused to the nerve centres. In one experiment mice were cured of syphilis at the sacrifice of their sense of hearing; the deaf mice lost all sense of balance and direction, and careered round and round their cages in circles, like dancing dervishes.

Months went by, and years. Six hundred and five modifications of atoxyl had been tried and had failed. Then, in May, 1909, the six hundred and sixth was made. It was found that 1/57 of the maximum tolerated dose of this substance cured spirillosis in hens; 1/5 to 1/7 of the maximum tolerated dose cured relapsing fever in mice; and, what seemed even more significant, 1/7 of the maximum dose, given in one intravenous injection, killed all the spirochaetes in the syphilitic sores on a buck rabbit in twenty-four hours, without any accompanying ill-effects.

It seemed safe to carry the experiment further. 60,000 doses of the substance were distributed to specialists competent to administer it. The results were, on the whole, satisfactory, and its most serious drawback seemed to be that it occasionally brought on a mild attack of jaundice. The drug was named 'Salvarsan' and became the regular treatment for syphilis.

Experiments still continued, and in 1912 the nine-hundred-and-fourteenth modification was found to be a considerable improvement on the six-hundred-and-sixth, and was adopted in its place under the name of 'Neo-salvarsan'. It is not, indeed, the treatment in use to-day, and it was found to be a more effective cure for relapsing fever than for syphilis, but it was a selective bactericide, a beginning if not an end.

For the importance of Ehrlich's discovery was not so much the achievement of one particular cure as the opening up of a new field of research. It was not the universal remedy he had hoped for, but it suggested the possibility that other chemical remedies might be found for other parasitic diseases. The search had become a problem for the chemists now that disease could be produced for experimental purposes in a test tube or on a Petri dish. Manufacturing chemists in Europe and America set up research laboratories and installed elaborate apparatus. The firm of Bayer, in Elberfeld, produced Bayer 205 (or Germanin), Tryparsamide, and Orsanine, all remedies for sleeping sickness. But the search was no easy one, as Ehrlich's six hundred and five failures had shown, and many years of sparsely rewarded activity went by before a discovery comparable in importance to the famous 606 was made. This was a drug that reduced the mortality rate of pneumonia from about twenty-five per cent to about six per cent, in other words it saved nineteen lives in every hundred threatened by the disease.

At the beginning of this century pneumonia was a dangerous crisis disease. It had a place with plague and scarlet fever in the novelist's dramatic resources, for anxiety mounted with the patient's temperature to the tense moment when life and death hung in the balance. But as such the young doctor of to-day would hardly recognise it.

The usual treatment, as for many other febrile conditions, was quinine and expectorants, but these did little to modify the course of the disease, and the patient's best hope lay in careful nursing.

The pneumococcus bacillus had been discovered by Fraenkel in 1886, and it was possible, therefore, following the pattern of Ehrlich's research, to test the effect of various modifications of quinine in the laboratory. And, still following his method, hundreds of modifications were made and tested without result. At last, after years of fruitless search, a quinine compound containing sulphanilamide was made which destroyed cocci in the test tube. In 1932 Gerhard Domagk, working in the Bayer research department, found that a red dye, containing a sulphonamide group, had a high ratio of success in curing streptococcal infections in mice. Shortly afterwards his daughter, working with him in the laboratory, became accidently infected with streptococci, and was successfully treated with this compound. Further tests were made in a quiet way and the results seemed promising. In 1935 this red dye was patented by the firm of Bayer under the name of Prontosil. Other research laboratories became interested, and the Pasteur Institute soon discovered that the prontosil molecule was split in the body, and only one part of it, the sulphanilamide, was required to kill bacteria. Sulphanilamide (p-aminobenzine sulphonamide) had been synthesised in 1908, and was a common chemical unaffected by the Bayer patent. It could be manufactured in large quantities and made available for general treatment.

In London it was tested at Queen Charlotte's Maternity Hospital on patients suffering from puerperal fever, which was known to be a streptococcal infection. Although the incidence of this disease had been considerably reduced by aseptic and antiseptic methods the mortality rate of those who actually contracted it was still some 20 per cent. Of the sixty-four experimental cases on which the new drug was tried only three died. A doctor who was working at the hospital at the time has written: "The most tragic work I have ever had to do was looking after those poor women, for if the haemolitic streptococcus was found in the blood stream there was no hope of survival. Then, one day in 1935, Prontosil, the first of the sulphonamides, was introduced, and the scourge of puerperal fever was banished."

Other modifications of the drug were manufactured and tested. Sulphapyridine, the six-hundred-and-ninety-third modification, made by the firm of May and Baker, and known as M & B 693, further reduced the mortality rate of pneumonia. The character of the disease was altogether changed. In place of the steadily mounting temperature the fever abated rapidly, and the majority of patients recovered in a few days. To doctors who had previously had no more effective remedies than quinine and expectorants at their command it seemed something of a miracle. Even patients occasionally regarded their doctor as a miracle-worker, as indeed he was if a miracle may be defined as something that transcends the normal course of nature. The saving of nineteen lives that would be doomed to death if the activities of bacteria remained uninterrupted is surely a miracle more worthy of note than the cure of some neurotic suffering from a disease of doubtful diagnosis.

After a few years M & B 693 was superseded by M & B 760. This was not discovered in the May and Baker laboratories, but by American workers, who courteously waived their own claim to its nomenclature and retained the name given to the earlier product by the British firm.

The effectiveness of the sulphonamide group of drugs against staphylococcus, pneumococcus, and meningococcus was firmly established, and although penicillin now has priority in the treatment of these infections, the sulphonamide provide a useful alternative, and have countless lives to their credit.

This story may appear to have strayed a little from the doctor's surgery into the chemist's laboratory. It has done so only to explain some of the remedies at the doctor's beck and call when he sits down with his fountain pen and little pad (N.H.S. E.C.10), and with an air only not casual because of his concern for the patient writes a formula as potent as would "summon spirits from the vasty deep". Had the old alchemist witnessed the working of the new drugs he would have believed the doctor to be nothing less than a magician.

The story now turns to find a fitting close in the small room that was Professor Alexander Fleming's laboratory in the agglomeration of rambling buildings close to Paddington Station that form St. Mary's Hospital. The incident has been many times recounted. No doubt in the first place it was an accident, similar to the accident that resulted in the discovery of radium. No doubt accidents often happen, in laboratories as elsewhere, and this particular accident had probably happened before in other laboratories. It is not the accident that is remarkable but the alert curiosity that takes note of the accident, that wonders how and why it has happened, and what is its significance in nature's chain of events. Curiosity of this kind, analytical, contemplative, constructive, is one of the strongest of the religious impulses of modern times. It is a selfless interest in the workings of nature, surely the least equivocal revelation of the mind of God.

What Professor Fleming saw, one day in the year 1928, in his rather dingy laboratory—for a film of smoke comes between Paddington and the day's bright eye—was that a mould had drifted into the room and contaminated an agar plate on which colonies of staphylococci were being cultured. Looking closer he noticed that in the neighbourhood of the mould the staphylococci appeared to be dissolving. The plate was useless for its original purpose. It might well have been thrown away. But, useless though it might be, there was something interesting about it, for here was a natural substance that was acting as a disinfectant, and Professor Fleming was as interested in disinfectants as Lister had been. The mould must be identified.

First he photographed the plate. Then he removed some of the mould and cultured it. It sounds like fun in the laboratory, and it probably was, but it was the kind of creative fun out of which come great works of art or of science. He identified the mould as Penicillium Notatum, a relative of, but not identical with, the blue mould that grows so readily in the larder.

Then he began to experiment with it. He found that when it was cultivated in a nutrient broth the broth itself acquired antiseptic properties, which it retained when the mould had been filtered off. Even when it had been diluted many times the broth still inhibited the growth of bacteria. It was known in the laboratory as 'Fleming's fluid mould'; the irreverent called it 'Fleming's mouldy fluid'. We now call it penicillin.

Experiments went on. Before the end of 1929 some remarkable facts had been established. One part in sixty millions was effective against: (1) staphylococcus aureus, which is found in wound infections, carbuncles, boils, osteomyelitis, and septicæmia; (2) streptococcus pyogenes, found in puerperal fever, sepsis, pneumonia, meningitis, wound infections, and septicæmia; (3) pneumococcus, found in pneumonia, meningitis, and mastoid infections; (4) meningococcus, found in epidemic meningitis; and (5) the bacillus anthrax. A little stronger mixture, one in forty millions, killed streptococcus viridans, a cause of chronic infection of the valves of the heart; a stronger mixture still killed the diphtheria bacillus; and a weak mixture of about one in a hundred and twenty millions killed the gonococcus.

Here, then, was a natural substance derived from a fungus that even in minute quantities acted as a powerful bactericide. To what practical use could it be put? It had serious limitations. During production the broth filtrates easily became contaminated, and their bactericidal virtue was lost in a very short time. Professor Fleming passed on his discovery to the London School of Hygiene and Tropical Medicine, where it was subjected to another series of experiments. An unfavourable report was made on its stability; its practical value did not appear to be very great. However, it was found useful in the laboratory in separating bacteria that were sensitive to it from those that were not, a considerable service in a hospital, where the identification of disease-bearing bacilli in swabs taken from patients is a matter of urgency. It was also used occasionally as a dressing for septic wounds, and was found less irritating to the tissues than other disinfectants.

At this time in Sheffield, and later in Oxford, work was going forward on the investigation of other bactericides. The work already done in London suggested that Penicillium Notatum, in spite of its shortcomings, warranted further research, and in 1939, eleven years after its discovery, work on its isolation and purification was begun by the staff of the Sir William Dunn School of Pathology under Professor Florey. The antiseptic broth was reduced, without any diminution in its potency, to a yellow powder, and a method was devised of measuring the potency. In May, 1940, the powder was tested on a streptococcal infection in mice. Eight mice were injected with a lethal dose of streptococci, and four of them received at the same time a dose of the yellow powder. Twenty-four hours later four of the mice were dead, but the four dosed with penicillin were alive and well. It was a result unequalled by any bactericide except the sulphonamides. Hopes were raised that it might be as effective for humans as it was for mice, but there were difficulties enough to daunt all but the most optimistic. Measured by their relative weights a man would require a dose from 3,000 to 4,000 times as large as the dose for a mouse. Penicillin was difficult to cultivate in large quantities, and with the increase in quantity the danger from contamination increased. It was very unstable, and easily destroyed by slight chemical changes, or by air-borne bacilli, which were difficult to avoid in the course of production. Nor was there any guarantee in the fact that it was harmless to mice that it would be equally harmless to man.

The work went on through the year 1940, the Battle of Britain being waged in the air above, the battle of humanity on the ground below. By February, 1941, the Oxford workers had produced enough for a trial. The first patient on whom it was used was a policeman in St. Mary's Hospital who was dying of septicæmia. For five days he was treated, and during the course of the treatment his condition improved considerably. Then the hard-won supplies ran out. The treatment had to come to an end, and the patient relapsed and died.

As supplies became available other cases were treated, and improvement was invariably recorded. Moreover penicillin appeared to be perfectly harmless. The tragedy was that there was not enough of it. In the England of 1941 material and workers were scarce, and factories were a legitimate target for enemy bombs. Here was something that might save hundreds, even thousands, of lives if only it could be manufactured, but the resources were not available. Professor Florey decided to cross the Atlantic and enlist the help of American drug firms.

In the summer of 1941, at the invitation of the Rockefeller Foundation, he and his colleague Dr. Heatley met representatives from the American chemical industries and American research workers, under the leadership of Dr. A. N. Richards, Chairman of the American Committee of Medical Research. Experience gained in England was passed on to the States and arrangements were made for a continual interchange of information. Commercial firms set to work with the *élan* characteristic of their country, and in the first five months of 1943 they produced four hundred million units. By the spring of 1944 enough penicillin was available for the treatment of all casualties in the Allied Forces and all bomb victims, and in the single month of August, 1945, they produced eight hundred thousand million units.

Meanwhile production in England was by no means abandoned. Equipment was scarce, but scientists are great improvisers and they made use of anything they could lay hands on, milk cans, baths, even pipes and taps from the plumber's kit. Early in 1945 ten cases of severe staphylococcal infection were treated, and this time the supply of penicillin was adequate. All ten recovered. In addition a hundred and seventy-two cases of localised infections were successfully dealt with. It was not long before production kept pace with requirements, and in a surprisingly short time there was penicillin for all who needed it. There was penicillin, too, for further research. Medical students volunteered to act as 'guinea-pigs' and were dosed both by mouth and by injection with increasingly large doses, and their blood examined at intervals for its 'penicillin level'. They came to no harm, but they often had to forgo their breakfast, a small sacrifice that can easily be underestimated by those of maturer years.

In the early days penicillin was very expensive to produce and the daily dose cost something in the neighbourhood of five pounds. This has now been reduced to about half-a-crown, which, in countries where the sick must bear the cost of their own medicines, is still more than can be afforded by the very poor. It may go some way to reconcile the recalcitrant to State Medicine to realise that under such a service the effective treatment of the patient is dictated not by his purse but by his need.

Penicillin is not a universal panacea. There are conditions on which it has no effect at all because the bacilli that cause such conditions are insensitive to it. Among these are the bacillus typhosum, the cholera vibrio, the tuberculosis bacillus, the viruses of poliomyelitis and influenza, and all the protozoa. But the gonococcus, the staphylococcus, the streptococcus, and the spirochaete are all sensitive to it. It is possible, indeed, to cure an acute invasion of gonococci in a matter of a few hours by two-hourly injections of 300,000 units.

But if it is not, in the accepted sense of the words, an Elixir of Life, it has given life and health to thousands who without it would have been in their graves. The great work of Professor Fleming and Professor Florey has been publicly acknowledged, and they have received honours all over the civilised world. We know them now as Professor Sir Alexander Fleming and Professor Sir Howard Florey, and in our hearts we give them prouder titles still, for to them the words with which John Baron described the work of Jenner are equally appropriate: they "lived at a time when the whole of the civilised world was ravaged by a war of almost unequalled ferocity . . ." and they have "the supreme gratification of knowing that (their) discovery has been the means of saving more millions of lives than had been sacrificed during the murderous conflict."

And so this small book, which has given so much pleasure in the writing, comes to an end, not indeed for lack of matter, but because the patience of the gentle reader must not be tried beyond so many pages, and it is better to leave him ready for more than surfeited with too much. As it has been told, the tale bears a relationship to the activities of doctors the world over comparable to that of a bunch of flowers to the flora of a continent. It has not been gathered entirely at random, and it is offered as an apologia and a tribute.

Index

ABBOT, Gilbert, 159
Abbots Bromley (horn dance of), 28
acarus scabiei 69
Ackworth School, 167
Adventu Medici Ægrotum (de), 75–78
Aetiologie, Begriff, und Prophylaxis des Kindbettfiebers, 166
Aesculapius, 10, 155
Airs, Waters, and Places, 40–43
Alexandria (library of), 21, 36
America (first use of anæsthetics in), 157–63
  (production of penicillin in), 233–34
anæsthetics, 48, 147, 153, 154–63
Ancient Medicines (Treatise on), 38, 39
anatomy, 50, 81–87, 91–93, 95, 100, 105, 106 (*see also* surgery)
Anatomical Essay on the Movement of the Heart and Blood in Animals, 93, 94
Anderson, Dr Thomas, 168, 169
anthrax, 181, 195–99, 207, 209–11, 220, 224, 231
antigens, 219
antibodies, 219, 221
antiseptics, 147, 153, 164–80
anti-serum, 219
anti-toxins, 48, 217–20, 221, 224
Antoninus (Emperor), 53
Antonius Musa, 52
Aphorisms, 37–38
apothecaries, 62, 77, 78, 147
Arabian medicine, 57, 70, 71
archiatri, 53, 65
Archimathaeus, 75
Aristotle, 50, 51
Arundel (Earl of), 95, 96
Asclepiades of Bithynia, 52
Aubrey, John, 91, 92, 97, 98
Augustine Canons, 59
Augustus (Emperor), 52
Averroes, 71
Avicenna, 71

BABYLONIAN medicine, 7, 15–17, 50
bactericides, 221–35
Bald, *see Leech Book of*
Banks, Sir Joseph, 125
barbers and barber-surgeons, 46, 148–52
Baron, John, 125, 128, 131, 142, 145, 234
Bayer, 227, 228
Beale, Mary, 114
Bede, the Venerable, 66–68
Bedlam, *see* St Mary's of Bethlehem
Behring von, 200
Benda, 226
Bertheim, 226
Beverley, John of, 66
bleeding, 67, 68, 77, 78, 115, 116, 148, 149
Boer War, 214
Boyle, Robert, 94, 106
Brady, Dr , 110
Brauell, 195
Breasted, Professor, 18, 19
Bridewell, 61
British Museum, 114
Brown, Dr Lancelot, 89
Bruce, 204
Buchan, Dr William, 56

CAIUS College, 86, 87
Calcar, *see* Kalkar
Caldwell, Dr , 91
Calvert, Mr Grace, 173
Camillus, Furius, 56
carbolic acid, 172–73
carminative, 5
Carnatum, 55
case histories, 45, 46, 49
Castellani, 204
castor oil, 24, 31
Chamberland, 209
Charles the Fifth (Emperor), 85
Charles the First, 91, 95, 98
Charles the Second, 101, 116, 122, 182
charms and incantations, 5–8, 15, 16, 19, 22, 24, 25, 66, 78
Cheselden, William, 153
chloroform à la reine, 163
cholera, 188, 203
Christian influence on medicine, 49–51, 57–60, 63, 66
Christ's Hospital, 61
Cild, 68
circulation of the blood, 29, 30, 92–94
Civil war, 98, 102–104
Clarke, William E , 158
Clayton, Sir Thomas, 105

climate, influence of on health, 41, 42
Clinch, John, 128
Clissold, the Rev., 124
Cline, Henry, 139
Cock, Dr. F. W., 161
Cockayne, Rev. Oswald, 68
Cole, Dr. William, 117, 119
College of Physicians (Royal), 88, 89, 91, 93, 98, 99, 100, 107, 109, 113, 132, 151
College of Surgeons (Royal), 150–53
Colton, Dr. Gardner Q., 159
Columbus, 86, 94
complement, 220
Comrie, 15, 16
Conquest of Disease, 220
Constantinople, sack of, 80
Constantinus, 71
contagious magic, 7
Cook, Captain, 126, 127
Cos, *see* Kos
Coxe, Dr. Thomas, 104
cowpox, 125, 133–40, 207
craft guilds, 150
Cromwell, Richard, 108
Cuckoo, Observations on the Natural History of the, 131–33
Cyngfrid, 68

Davy, Sir Humphrey, 156
Davaine, 195
Development, Treatise on, 96
diet, 43, 44
diphtheria, 217, 218, 220, 231
Disquisition about the Final Causes of Things, 94
Dover, Dr., 114
dropsy, 108, 109, 112
dwarf, types of, 92
dyeing and staining, 200, 202, 222–25
dysentery, 220, 222

Ebers, Georg, 18–20
Ebers Papyrus, 18–32
Edgehill, battle of, 98, 102
Edward the Fourth, 151
Edward the Sixth, 61
Edwin Smith Papyrus, 18–20
Egyptian medicine, 17–32
Ehrlich, 200, 219, 223–27
electuary, 77, 78
elephantiasis, 69
emetine, 221
Ent, Dr., 93, 100
Epidemical Diseases, 110
Epidemics, 40, 45
Evelyn, John, 106
Exercises on the Generation of Animals, 99

Fabricius, 86, 87, 94
facies Hippocratica, 44, 45
Fallopius, 86
Faraday, Michael, 156
Fielding, Lord, 96, 97
Fischer, 203
Fleming, Sir Alexander, 230–35
Florey, Sir Howard, 232–35
Folk medicine, 27, 28, 65, 66
fowl cholera, 207–209
Fraatz, Emmy, 192–94, 203
Fractures and Joints, 46, 47
Fraenkel, 228
Frazer, Sir James, 7
Friend, Dr. John, 72, 74
Frobenius, 156
Frost, Eben H., 159

Gaddesden, John of, 64, 65, 72–75
Gaffky, 200, 203, 204
Galen, 50, 71, 73, 81, 82, 84, 85, 94, 105, 150
Gardner, Edward, 127, 129, 130, 131, 133, 134, 135
Gee, Mary, 108
Gee, Mrs., 114
Geschichte der Botanik, 66
Gilbert the Englishman, 64, 65, 72, 73
Glasgow Infirmary, 164, 177, 178
Glasgow University, 170, 172
glossina palpalis, 204
Goddard, Dr. Jonathan, 107
gout, 108, 112, 115, 118
Gram test, 223
Grancher, Dr., 213
Greek medicine, 33–48, 51, 70
Greenlees, James, 174
Gregory, Dr., 163
Guy's hospital, 63

Hahnemann, 9
Halk, Joan, 86
Hammurabi, Code of, 17
Harvard Medical School, 159
Harvey, Eliab, 100, 101
Harvey, Elizabeth, 89
Harvey, Thomas, 86
Harvey, William, 85–101, 103, 113, 168
Harvey, Dr. Gideon, 110
Hata, 226
Hayward, Dr., 160
Heatley, Dr., 233
Henle, Jacob, 188, 191, 195, 197
Henry the Eighth, 61, 88, 151, 152
herbs, medicinal, 11, 12, 58, 66, 68, 69
Hermes, 20, 21, 23
Herodicus of Selymbria, 36
Hickman, Henry, 156, 157

Hicks, Henry, 129
Hippocrates, 3, 33–48, 105
Hippocratic Corpus, 36–48, 105, 148
Hippocratic Oath, 34
History of Surgical Anæsthesia, 161
Holbein, 152
Holmes, Oliver Wendell, 160
homeopathy, 9, 11, 130
Homer, 35
hospitals and spitals, 51, 53, 55, 57–63
humours, the four, 71
Humani Corporis Fabrica (de), 82–85
Hunter, John, 83, 120, 125–28, 130, 145, 153
Hunter William, 125, 126, 153
hydrophobia, *see* rabies
hysteria, 105, 106, 117, 118

IMHOTEP, 21
immunology, 207–220, 224, *see also* inoculation and vaccination
incantations, *see* charms
inoculation, 121–23, 125, 134–40, 146, 207–14
Inquiry into the Causes and Effects of the Variolæ Vaccinæ (An), 126, 129, 136–39
ipecacuanha, *see* emetine
Invisible College (The), 89, *see also* The Royal Society

JACKSON, Dr. Charles A., 159
James the First of England and Fifth of Scotland, 86, 88, 89, 90, 91
Jenner, Catharine, 133
Jenner, Edward, 120–46, 207, 208, 220, 234
Jenner, Edward, 128, 133, 134, 145
Jenner, Henry, 123
Jenner, Henry, 131, 133, 138, 145
Jenner, Robert, 133, 138, 144
Jenner, The Rev. Stephen, 123
Jenner, Stephen, 123, 127
Jenner, Stephen, 146
John of Mirfield, 148
John of Gaddesden, *see* Gaddesden
Jones, W. H. S., 37
Joints, the Treatise on, 47
Julius Caesar, 52
Justinian, Code of, 51

KAISERLICHES, Gesundheitsamt, 199
Kalkar (or Calcar), Johann Stephan von, 83–85
Keys, Thomas E., 161
Kingscote, Catherine, 131, 145
King's College, London, 172, 180
King's College hospital, 178, 180
Kitasato, 200, 204
Koch, Robert, 140, 180, 181, 184, 189–205, 206, 207, 209, 214, 224
Koch, Gertrud, 193, 194
Kohn, Ferdinand, 199
Kohnheim, 199
Kolletschka, 166
Kos, 35, 36

LANCASHIRE witches (the), 95
Lancet (The), 168, 172, 173, 174, 175, 177, 178
Larissa, 36
Lazar houses, 60
Leech Book of Bald (The), 68, 69, 70
Leechdoms Wortcunning and Starcraft of Early England, 68
Leeson, J. R., 165
Leeuwenhoek, Antony van, 181–83, 201
Leonardo da Vinci, 82
leprosy, 60, 220
leucocytes, 219, 220
licensing regulations, 53, 54, 78, 88, 153
Lister, Joseph, 154, 165–80, 197, 230
Liston, Robert, 153, 161–63, 165
Leoffler, 200
London hospital (the), 63
Long, Crawford W., 158
Lumleian lectures, 94, 99
Lull, Raymón, 155

MACDONALD, Greville, 178
Machaeon, 35
Mackinney, 66
malaria, 40, 203, 206, 220, 221
Malpighi, 181
Malthus, Daniel, 113
mandrake or mandragora, 11, 12, 155
Mapletoft, Dr. John, 104
Marten, Dr. Benjamin, 182–89, 216, 219
Martial, 52, 53
Massachusetts General hospital, 159
May and Baker, 229
mediaeval medicine, 64–79
medical education, 34, 40, 44, 51–55, 62, 63, 77, 81, 91, 104–107, 110, 149, 152
Medical Registration Act, 153
Medicine Among the Assyrians and Egyptians in 1500 *B.C.*, 15
Meister, Joseph, 213, 214
Merton College, 72, 99, 103
mesmerism, 163
Metchnikoff, 219, 220, 222
Method of Curing Fevers, 114
Meyer, 66
microphotography, 200, 201

Middlesex hospital, 63
migraine, 69
mimetic magic, 6, 7, 16, 22, 25
Mirfield, *see* John of
Morgenroth, 226
Montague, Lady Mary Wortly, 121
Montpellier, 54, 70, 71, 72, 109
Morton, William, 159–60
Mundinus, 81

Nature of Man, The, 36
Nature of the Bones, The, 36
Nelmes, Sarah, 135, 137
Nero, 52
Nestorians, 70
Newsholme, 164
New Theory of Consumptions, A, 183–186
Novaesium, 55
nursing, 62, 165

OPSONIN, 220
organisms of disease (list of discovery of), 205

PADUA, 83–88
papyri, 18–32
Paracelsus, 150, 155, 156, 222
Paré, Ambroise, 150
Parry, Dr., 136
Pasteur, 71, 167, 169, 170, 178, 180, 183, 185 *n.*, 191, 197, 199, 207–14
Pathologische Untersuchungen, 191
Pechy, Dr. Thomas, 105, 109
penicillin, 229–235
Pennsylvania, University of, 158
Perroncito, 208
Petri, 200
Petty, Dr. William, 105
phagocytes, 219, 220
Phipps, James, 135, 137
plagues of Egypt, 2
Plato, 35
Pliny, 51
pneumonia, 227–29, 231
Podalirius, 35
Pollender, 195
Polybus, 36
Pope, Dr. Elijah, 158
possession by devils, 8, 50
Pott, Percival, 153
Priestley, Joseph, 156
Prognosis, 39, 44
protonsil, 228
Ptolomy Philadelphus, 36

QUARANTINE, 96, 97
Queen Charlotte's hospital, 63, 228
quinine, 221

RABIES, 71, 211–14
Rahere, 59
Rayer, 195
Reed, Dr.
Researches Chemical and Physical Chiefly Concerning Nitrous Oxide, 156
Rhazes, 71
Rice, 220
Riggs, Dr. John M., 159
Roman medicine, 49–55
Rosa Medicinæ, 72
Royal Society, 100, 105, 131, 132, 156, 157, 180, 182, *see also* Invisible College
Roux, 203, 209, 213, 222

SALARIES and fees, 62, 76, 77, 90, 91
Salerno, 54–55, 71, 75, 77, 90, 91
salvarsan, 225–27
Schaudinn, 225
Semmelweiss, 166, 167
Seneca, 52
Servetus, 94
Severus, Alexander, 53
Severus, Lucius Septimus, 53
signatures, doctrine of, 9
Silvius, 83
simples, 69, 77, 78
Simpson, Sir James Young, 154, 160, 163, 179
sleeping sickness, 204
Sloane, Sir Hans, 98, 114
smallpox, 71, 73, 74, 106, 120–22, 125, 133–40, 146, 206, 220
Speyer, Georg, 225
spitals, *see* hospitals
St. Bartholomew's hospital, 59–63
St. Côme, College of, 150
St. George's hospital, 63, 125
St. Mary's of Bethlehem, 60, 62
St. Mary's hospital, 230–32
St. Thomas's hospital, 58, 59, 61, 62, 139, 165
sulphanilamide, 228
sulphonamide, 229
Sumerian medicine, 10, 14–16
surgery and surgeons, 16–19, 29, 34, 38, 46–48, 55, 59, 62, 74, 90, 123, 124, 127, 147–53
Surgery, in the, 46
Sutton, Daniel, 122
Sydenham, Francis, 103
Sydenham, Thomas, 36, 91, 102–19, 141, 183
Sydenham, William, 102, 109
Sydenham, William, 109
Syme, Professor, 154, 168, 178
sympathetic magic, 7, 15, 68

TABOO, doctrine of, 2, 5
Tacitus, 66
tetanus, 217, 218, 220
Theodore, Archbishop, 66, 67
Theodoric of Bologna, 148
theriac, 77
Thomas, Hugh Owen, 153
Thoth, *see* Hermes
Thuillier, 203
Tiberius, 52, 55
totemism, 7, 9, 10
Toussaint, 208
toxins, 217, 218, 225
Trye, Charles Brandon, 154
tsetse fly, 204
tuberculosis, 183–87, 201, 202, 216
tuberculin, 202, 224
typhoid, 200, 214, 220

UNIVERSITY College, London, 168
University College hospital, 165

VACCINATION (*see also* inoculation), 137–40, 142, 144, 146, 207, 208, 211, 215
Valentinian, 53
Venable, James M., 158
Venarum Ostiolis (de), 87
venereal diseases, 184, 200, 222 225–27, 234
Vesalius, 82–87, 94
Vespasian, 53
Vicary, Thomas, 151
Victoria, Queen, 163, 165, 179
Virchow, 192
Vulpian, Dr., 213

Warren, Dr. John C., 159
water supply, 56–57
Weigert, Carl, 223
Wells, Horace, 159
Wells, Spencer, 153
Westminster hospital, 63
Wilson, Professor George, 154
Withington, E. T., 37
Worgan, John, 141, 142, 145
Wounds in the Head, 46
yellow fever, 220

ZANTHE, 85